Integrating Socioeconomic Analysis Into NOAA Decision-Making

Social Science Workshops for Mission Goal Teams

Briefing Book

Climate

NOAA Program Planning and Integration

April 30, 2004

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Part 1: Agenda and Background Materials

Introduction

Workshop Agenda

Agenda for NOAA Climate
Social Science Mission Goal Team Workshop

April 30, 2004

Workshop Objectives

- Increase understanding of uses and benefits of social science in NOAA
- Identify research projects to assist in planning and decision-making
- Plan for increased use of social science in FY 06 and subsequent years

The workshop emphasizes approaches to facilitate product development in response to the Program Decision Memorandum.

Summary Agenda

Introduction

Integrating socioeconomic analysis into NOAA decision-making
Applying social science in NOAA decision-making

Applications of Social Science to the Climate Mission Goal

Examples of use of social science in decision-making
Social science research at OGP

Moving Forward with Social Science Integration and Supporting Projects – discussion

In what areas is social science needed?
What projects would you suggest to fill those needs?
Features of an integrated social science research plan

Agenda

Introduction

Integrating Socioeconomic Analysis Into NOAA Decision-Making

Rodney Weiher

Objectives and overview
Social science program background and strategy
Workshop focus

Applying Social Science In NOAA Decision-Making

Irv Leveson

The role of social science in decision-making and management
Applying tools to climate – some methods and uses
Applying tools to new markets and products

Applications of Social Science to the Climate Mission Goal

Examples of Use of Social Science in Decision-Making

Tom Teisberg

Need to link predictions of seasonal to inter-annual climate variations to the needs and values of those forecasts — to provide prediction products that help users deal with emerging trends in climate. Elements to be illustrated with a project underway include:
Inventorying products and identifying users of those products
Developing methods of estimating economic benefits, including modeling/operations and interview/survey methods

Social Science Research at OGP

Harvey Hill,
Nancy Beller-Simms
and Claudia
Nierenberg

Overview of OGP programs and their relation to other NOAA activities
Examples of current work emphasizing product-related research for U.S. mission goals
Needed research relating to mission goal team responsibilities, including climate transition program needs for work on validation and verification issues, geographic issues and anthropological issues

Moving Forward with a Social Science Research Plan

In what *areas* is social science needed?
Priorities?
Where can social science make a contribution it is not now making?
What are the benefits across NOAA?

What *projects* would you suggest to fill those needs?
Subject, objective and scope for each project
How are they related to what has been done or is underway and to what has been newly authorized or funded?
What is needed to get them going?

Features of an integrated social science research plan
Rationale, structure/process, products, benefits

Email from Mary Glackin to Mission Goal Team Leads

to Set Up Workshops on Uses of Economics and Social Science, Feb. 2, 2004

Following up on the 06' Program Guidance and Science Advisory Board recommendations to make greater use of social science in NOAA planning and decision-making, we are proceeding with a series of NEP funded workshops for senior management, beginning with the mission Goal Team leads and program managers.

The workshops will discuss how social science can contribute to understanding and decision-making, examples of current and potential uses in NOAA, and efforts to integrate social science into NOAA's PPBES process. I think you will find this especially helpful in dealing with issues that encompass multiple programs and line offices.

For example, uses in Ecosystem Management could include:

- Measuring benefits and costs in protecting and restoring coastal and ocean resources, while accounting for interactions between ecosystems and human populations.
- Predicting how individuals, groups and organizations behave in the absence of regulation and under differing ecosystem management and governance arrangements.

Examples in Climate include:

- Identifying and quantifying economic benefits of emerging NOAA climate information and services.
- Assessing economic and societal effects of climate change and implications of prediction accuracy and uncertainty.

Examples for Weather and Water include:

- Predicting demands for, uses, and users of water resource program services and assessing potential ways of enhancing their value.
- Assessing how forecasts and air quality research can be used to improve environmental management.

For Commerce and Transportation, examples might include:

- Estimating impacts and benefits of NOAA information and services for inter-modal transportation and developing measurement systems to monitor impacts.
- Assessing demands for new information and services, including levels of demand, uses and users, while accounting for changes in economic

conditions and incentives for solutions to evolve in the marketplace that change needs and users.

A separate seminar will be held with each goal team lead and the program managers within that mission goal. Workshop presenters will be largely outside experts in applied economics and social sciences experienced in NOAA programs. The workshops will be informal and are planned over the next several weeks, lasting 2-2-1/2 hours. These will be followed by sessions with appropriate NOAA councils and leadership.

My office will be contacting you to set up your workshop. Rodney Weiher, our Chief Economist, is organizing and leading the workshops. Your timely response is appreciated

Mary Glackin
Assistant Administrator
Program Planning and Integration

Definitions of Social Sciences

SOCIAL SCIENCE DEFINED: The process of describing, explaining and predicting human behavior and institutional structure in interaction with their environments.

Economics: Allocation of scarce resources among competing ends - to understand how individuals, groups and governments, faced with limited resources, choose to produce, distribute and consume goods and services.

***Sociology*:** Structure of human societies and the behavior of individuals, groups and institutions in society.

Anthropology: Physical, social and cultural development and behavior of humans.

Demography: Human populations, including size, growth, density, and distribution; statistics on birth, marriage, migration, disease, and death.

Geography: Spatial distribution of human activity and the distribution of human interactions with the environment, including economic and cultural resources.

Psychology: How people think about, influence, and relate to one another, and cognitive psychology, including mental processes in response to stimuli that influence responses and the processing of information.

Political Science: Description and analysis of political institutions and processes.

Using Social Science

Social Science Can Help You:

- Determine the value of programs and demonstrate it to others

    ⇒ Determine the size of benefiting sectors
    ⇒ Estimate program-specific and agency-wide benefits for all beneficiaries and types of beneficiaries
    ⇒ Communicate more effectively
    ⇒ Understand and address stakeholder perceptions

- Decide which programs to support based on documented payoffs

    ⇒ Weigh to benefits and costs of different programs and scope and levels of particular programs
    ⇒ Take into account indirect effects
    ⇒ Deal with uncertainty

- Measure program performance in ways that better reflect impacts and costs

    ⇒ Properly define outputs and outcomes
    ⇒ Better measure costs and who pays
    ⇒ Identify impacted groups and systems

- Make choices among services, uses and distribution

    ⇒ Understand the size and nature of markets
    ⇒ Understand customer attitudes and behavior and their implications for demand
    ⇒ Design and choose among products and services
    ⇒ Understand implications of using alternative distribution systems

- Plan investments in physical and human resources

    ⇒ Take into account supply prospects and incentives for facilities and personnel
    ⇒ Define alternatives that can become available over longer time frames

- Assess interrelated programs and understand what groups of programs add up to

    ⇒ Take into account interactions among programs in determining costs, benefits, users, uses and distribution
    ⇒ Evaluate programs in ways that allow for interdependent effects

- Avoid unintended consequences

    ⇒ Understand the mechanisms by which changes occur and their strength
    ⇒ Examine farther-reaching and longer-term effects
    ⇒ Design feedback systems to allow correction and adaptation

- Develop targeted information systems

    ⇒ What to collect?
    ⇒ How to collect?
    ⇒ How to use and interpret?

- Promote longer term thinking and planning for initiatives with substantial lead times or long payoff periods

    ⇒ Sensitize staff to issues and importance
    ⇒ Utilize techniques that focus attention on longer term considerations

Some Uses of Each Social Science

Economics

Valuing benefits of programs.

Cost-benefit and cost-effectiveness analysis to determine payoffs to programs.

Estimating/forecasting demand for products.

Understanding incentives of participants in organizational and economic processes.

Sociology and Anthropology

Analyzing vulnerability of populations to weather and climate changes.

Examining adaptation to global change

Tailoring resource management policies and programs to cultural environments to increase effectiveness.

Examining NOAA organizational structures.

Designing community participation and governance structures for resource management councils.

Demography

Assessing population pressures on coastal resources.

Identifying populations that are vulnerable to changes in the availability of marine life.

Understanding changes in labor force sources for NOAA.

Geography

Defining environmentally sensitive areas.

Tracking movements of marine life

Defining ecosystem boundaries and analyzing interactions among ecosystems.

Designing configurations for integrating global observing systems.

Understanding choke points in inter-modal transportation with alternative configurations to assess the potential benefits of improved data.

Psychology

Providing methods for survey data collection, analysis and interpretation.

Understanding how constituents use data and services.

Designing stakeholder education materials to improve communication.

Political Science

Analyzing pressures for programs and reactions to programs and regulations

Understanding governance structures

Mission Goal Objectives Relating to Social Science

The use of social science for each mission goal should contribute to improved decision-making and understanding by:

1. Articulating and demonstrating the benefits of NOAA programs

   Developing information on the size of potentially impacted constituencies (people, regions, industries), direct and secondary benefits of information and programs and value of benefits for current and planned programs. Integrating information on benefits into NOAA processes and communications with constituencies.

2. Improving understanding of the user base

   Analyzing the size and composition of current and potential users of existing and planned services, uses made of the information or services, customer attitudes toward services, desired services, sources of similar services from other agencies and the private sector, responsiveness of users to alternative ways of distributing information or configuring information or programs, and impacts of changes in technology, industry structure and user organizing systems on the user base and services.

3. Analyzing resource management (as appropriate)

   Examining interrelationships within and among ecosystems, including roles of populations and economic structure and interactions between demographic/economic and biological processes, assessing the impacts of geographic and organizational arrangements for resource management and analyzing impacts of degrees and types of resource management on communities, industries and populations.

4. Developing techniques and databases appropriate to the above

   Methods and data should contribute to measurement of size of activity, valuation, perceptions, customer and system behavior, performance and outcomes and decision processes. Methods and data should help determine what changes are attributable to programs vs. changes that would have taken place in the absence of programs.

Key Social Science Questions

(from Social Science Panel report)

For Information Provision Missions, the basic goal is to ascertain the actual and potential value of the information they provide, including:

1. Who are the current and potential users of the information?

2. What attributes of the information are important (scale, timing, accuracy, etc.)?

3. How do people and organizations respond to the information?

4. What are the implications of weather, climate, and ecological forecasts for sectors of the economy and their relative value by sector?

5. What is the best way to package and transmit information so that it can be most easily understood and used by constituents?

6. What are the benefits of improving the existing attributes of the information?

7. For extreme events such as weather or high levels of variability in fish populations, what advanced planning can reduce uncertainty and expected damages?

For Regulation and Management, issues include:

1. What cultural, social, and economic factors determine the behavior of users of marine and coastal resources?

2. What is the value of market and non-market goods and services?

3. What effects will changes in user behavior have on the value and distribution of goods and services generated as well as on the resources, employment levels, value of output, costs of enforcement, etc.?

4. How does user behavior affect resources and what are the direct and indirect interrelationships between different users and different resources?

5. What behavioral and institutional changes achieve desired improvements in the status of the resources?

Some Social Science Research Applicable To NOAA

(from Social Science Panel report)

Programmatic, mission-driven research focused on background and operational information for NOAA to better define and carry out mandates and missions. Two major missions

1) Providing Information: NESDIS, NWS, OAR, NOS *(navigation and coastal hazards) provide information to facilitate routine activities (e.g., navigational charts; satellite imagery), and assist in decision-making (e.g., climatology, weather forecasting).*

Main emphasis is on:

- Assessing the value and usefulness of the information and how to enhance its value.
- Evaluating actual and potential benefits from decisions and actions based on the information.
- Cost-benefit and cost-effectiveness analysis of alternatives.

2) Regulation and management of marine and coastal resources: NMFS, NOS (coastal and habitat) –are driven by statutory mandates (MSFCMA, ESA, MMPA, CZMA) for stewardship.

Decisions absent regulation often results in misuse of resources.

Regulatory and management process requires information on current state and likely changes in resources and the people and economic entities that use them.

Main emphasis is on:

- Describing, assessing and predicting behavior of individuals, groups, and organizations that use or manage resources.
- Evaluating behavior under different regulatory and governance regimes. Assessing how behavior affects environmental, social, and economic variables.
- Ranking policy alternatives on the basis of their potential to meet the mandates of applicable laws.

Using Social Science for Mission Goals: Some Potential Examples

	Mission Goal						
					Cross-Cutting Priorities		
Issue or Tool	**Eco-system**	**Climate**	**Weather & Water**	**Commerce & Transp.**	**Global Obser-ving**	**Satellite**	**Ship Modern-ization**
Value of information Efficiency Convenience Warnings Resource management	Under-standing two-way interaction s between ecosystem s and people	Integrated assess-ment — integrating science and policy questions in global change analysis	Deciding which information and services to provide and how and to whom to distribute it	Understand-ing uses and benefits in improving the movement of people and goods	Under-standing the value of integrated informa-tion to various constitu-ents	Dealing efficiently with changing technolo-gies and require-ments	Balancing costs of capital and perfor-mance
Cost-benefit analysis Size/value of impacted sector Outcome Value of outcome Cost of activity Distribution of costs and benefits	Integrating biophysi-cal data with economic and demo-graphic data	Evaluating efforts to adapt to climate change	Assessing the payoffs to forecasts and warnings	Assessing the payoff to services intended to reduce risks to life, health and property	Taking into account the costs and benefits of combina-tions of data or systems	Assessing alternative configura-tions and trime-tables	Assessing alterna-tives including autono-mous and stationary platforms and sensors
Market and product analysis Size and nature of market Determinants of demand and behavior of customers Pace of market penetration	Under-standing attitudes of different publics toward resource manage-ment initiatives	Under-standing how people and businesse s use warnings to mitigate damage	Identifying emerging markets for information and services and effects of availability of services in creating markets	Identifying emerging markets for information and services	Under-standing how integrated data may be used and distributed	Assessing the ability of users to absorb the volumes and types of data to be generated	Anticipa-ting changes in infrastruc-ture and competing and comple-mentary military systems

Using Social Science for Mission Goals: Some Potential Examples (cont'd)

	Mission Goal						
					Cross-Cutting Priorities		
Issue or Tool	**Eco-system**	**Climate**	**Weather & Water**	**Commerce & Transp.**	**Global Obser-ving**	**Satellite**	**Ship Modern-ization**
Surveys Uses Users Willingness to pay or accept Survey methods	Under-standing uses and users of eco-systems	Determin-ing the value of lead times and probabi-ities of correct forecasts	Estimating willingness to pay for more localized services; Measuring "customers" respond to information	Measuring how industries, organiza-tions and governments respond to improved information	Integrating survey informa-tion from different settings	Under-standing uses and users in govern-ments as well as business-es and publics	Assessing frequency of readiness of existing vessels and reasons for lack of readiness
Regulation Devising incentives Anticipating impacts Evaluating impacts	Applying resource manage-ment techni-ques on an ecosystem scale	Assessing the cost of complying with restric-tions on activity in sensitive areas	Improving water manage-ment	Understand-ing regulatory barriers to adapting systems to take advantage of information	Assessing impacts of other countries' regula-tions on system design	Assessing conditions for licensing private satellites	Contribu-tion of vessels to ecosystem manage-ment
Dealing with uncertainty Defining possibilities Determining probabilities of outcomes Valuing outcomes	Allowing for uncertain or unintend-ded effects of resource manage-ment initiatives	Damage functions	Understand-ing effects of forecast uncertainty on use and benefits from use; Damage assessment	Understand-ing effects of forecast uncertainty on use and benefits from use	Determin-ing costs and benefits for different levels of utilization	Determin-ing the costs and benefits of redundant systems	Dealing with possible delays in availability while the existing fleet is aging
Defining data What to collect? How to collect? How to interpret?	Gauging interac-tions between popula-tions and eco-systems	Under-standing how informa-tion on carbon cycle and aerosols is used	Making effective use of the huge volumes of data that satellites will generate; Tailoring products to markets, users and uses	Developing measures of impacts of NOAA services on transporta-tion efficiency and difficulties	Prioritizing the many possible products and users for market research	Assessing how technolo-gy will change opportuni-ties	Accurately measuring availability and use

Using Social Science for Mission Goals: Some Potential Examples (concl.)							
	Mission Goal						
					Cross-Cutting Priorities		
Issue or Tool	**Eco-system**	**Climate**	**Weather & Water**	**Commerce & Transp.**	**Global Obser-ving**	**Satellite**	**Ship Modern-ization**
Defining performance measures Outputs Outcomes Indirect effects	Gauging outcomes against expecta-tions with different interven-tions	Examining how scientific attitudes change with improved informa-tion	Taking account of multiplied uses through efforts of the media and private industry	Including the value of people's time lost in congestion and the value of health and environ-mental effects in analyses	Determin-ing the increment al impacts of integrated vs. segmen-ted data	Taking into account the contribu-tion of each satellite or instrument that is part of a system	Taking into account multiple uses and redeploy-ments

Criteria that Can Help Identify the Greatest Potential Payoffs from NOAA Programs Include:

Criteria	Examples
Ability to improve understanding of fundamental processes	Research on mechanisms behind climate change; Fish migration
Ability to provide new kinds of information, manage large databases and integrate multiple types of information	Global observing systems; Software development for analyzing massive databases; International data sharing
Use in understanding or managing major long term impacts on human populations	Climate change causes and impacts; Applying improved tools of ecosystem management
Ability to improve the efficiency of industry or avoid unduly adversely impacting industry	Weather, water and mapping information for transportation and commerce; Evaluation of impacts of resource management programs
Large potential health impacts	Air quality measurement
Large variations in nature with potential major economic impacts	Water predictions; Climate variability programs
Cooperation among interdependent systems	International, national and regional ecosystem management
Small value to a vast number of people	Improved weather prediction accuracy and forecast horizons
Network economies that expand users and improve usability	Weather graphics and geographic detail
Contribution to national and homeland security	Weather over combat zones; Monitoring and predicting spread of contaminants
A significant likelihood of achieving the desired program results	

Roles of Social Science for NOAA Climate Products and Services

Major Program Components	*Types of Products*	**Examples of Roles of Social Science**				
		Measuring Value of Programs	**Deciding Which Programs to Support**	**Determining Services, Markets and Distribution**	**Measuring Program Performance**	**Planning Physical and Human Resource Investments**
1. Program Component: Climate Observations and Analysis (Tom Karl - NESDIS)	**Product support, etc.**	Determining contribution to value of various configurations of programs and users	Prioritizing information and services based on payoffs and costs	Identifying demands of users and uses, both from NOAA programs and from end users	Developing measures that reflect the support role of the activities	Prioritizing investments in systems for measuring and managing information
1.1 Observations (atmosphere, land, ocean, ecosystem, arctic, space) (Tom Karl)	Product support (origination)					
1.2 Data Stewardship (Tom Karl)	Product support (maintenance)					
1.3 Understanding Climate Variability and Change (CLIVAR, reanalysis, attribution activities) (Ming Ji - OAR)	Current data for planning and operations	Determining value in current and planned uses	Deciding how much to invest in current vs. potential programs	Gauging markets for potential products	Reflecting the diversity of users and uses	Considering investments in relation to those of partners
2. Program Component: Climate Forcing (Dan Albritton - OAR)	**Services in support of research and policy**	Understanding how the information is relied upon in decision-making	Prioritizing longer term and less certain information	Gauging uses in product development and policy under alternative climate scenarios	Developing ways of attributing policy actions to the information	Developing staff for activities in relation to capabilities and activities outside of NOAA
2.1 Global Carbon Cycle (David Hofmann - OAR)	Services in support of research and policy					
2.2 Atmospheric Composition (Dan Albritton)	Services in support of research and policy					
3. Program Component: Climate Predictions and Projections (Ants Leetmaa - OAR)	Forecasts	Identifying benefits to industries, public agencies and consumers	Taking account of interdependencies among programs in production and use	Understanding users and uses for products and distribution systems	Incorporating non-market benefits	Attracting and retaining highly skilled professionals
3.1 Climate Prediction (Intraseasonal to Interannual) (Jim Laver - NWS)	Forecasts					
3.2 Climate Change Projections (Decadal to Centennial) (Tom Delworth - OAR)	Forecasts					
3.3 Reducing Model Uncertainty (Isaac Held - OAR)	Forecasts					
4. Program Component: Climate and Ecosystems (Bill Fox - NMFS, Don Scavia - NOS)	**Current data for planning and operations**	Recognizing dependence on value of ecosystems to society	Recognizing opportunities for integrating physical data with economic and social data	Understanding incentives in resource management and governance systems	Determining contributions of programs to conditions of ecosystems, allowing for effects of human populations	Adapting infrastructure to changes in technology
5. Program Component: Regional Decision Support (Bob Livezey - NWS, Claudia Nierenberg - OAR)	**Decision Support Analyses and Assistance**	Determining benefits at the local and regional level	Identifying potential services, uses and users for evolving forecast capabilities	Assessing the uses of information and the roles of information in changing behavior of people and organizations at the regional level	Defining measures that reflect economic and social benefits at the regional level	Developing appropriate locations of activities for regional support

Using Social Science for Effective Surveys

- Determining the appropriateness of surveys vs. other approaches to obtaining information for particular purposes (e.g. interviews, focus groups, secondary data, etc.)

- Deciding what type of survey to conduct (how structured, how detailed, where administered, how often and whether repeated with the same people, etc.)

- Defining survey populations

- Developing sampling procedures

- Designing survey instruments

- Developing and wording questions

- Training interviewers

- Analyzing responses

    ⇒ Transforming data

    ⇒ Examining non-responses to survey and individual questions and other possible sources of bias

    ⇒ Analyzing data and distilling results

    ⇒ Interpreting findings in relation to initial expectations or theories, other surveys and data, interpretations of other studies, actual behavior of respondents, etc.

- Communicating objectives, procedures and conclusions

- Learning from the experience for future surveys

Using Social Science In Developing Performance Measures

- Using concepts in determining what measures to use and how to define them
- Understanding how people and organizations may respond to programs in order to know what kinds of effects to look for
- Using concepts and research to identify in which settings impacts may occur so steps can be taken to obtain measures from those settings
- Using survey and other methods to collect and interpret data on performance
- Understanding perceptions of changes that may influence how information is reported
- Developing predictions of outcomes in the absence of programs that can be compared with outcomes in the presence of programs
- Using models to estimate effects of programs while holding other things constant
- Understanding how programs may interact and how to deal with combined effects
- Developing performance measures that are consistent with measures of valuation and cost

Some Examples of Current Uses of Social Science in NOAA

Results of an email survey of social scientists in NOAA participating in group discussions with the Office of the Chief Economist
Information as of November 2003

Respondent contact information: Bob Leeworthy – N/MB7, (301) 713-3000 ext. 138, Bob.Leeworthy@noaa.gov
NOAA/NOS/Special Projects, 1305 East West Highway, SSMC4 9th fl, Silver Spring, MD 20910
http://marineeconomics.noaa.gov

NOS – Special Projects

Table 1 of 3

Project Name (assign one if one doesn't exist)	**Objective and Description of Project**	**Line Office and Program** (conduction or overseeing)	**Persons Responsible and Contact Information**	**Dates of Activity**	**Applicable NOAA Mission Goal(s) or Cross-Cutting Priority**	**Comments or Additional Information**
National Survey on Recreation and the Environment (NSRE) 2000	Quantify the number of people and number of days of participation in outdoor recreation activities in the marine environment.	NOS/MB/Special Projects/Coastal and Ocean Resource Economics Program	Bob Leeworthy – N/MB7 (301) 713-3000 ext. 138; Bob.Leeworthy@noaa.gov	Survey: July 1999 to July 2001 Analyses and Reports: Ongoing	Goal: Protect, restore, and manage the use of coastal and ocean resources. Cross-cutting: Sound, Reliable State-of-the-art Research	Multiple Federal agency Partnership. U.S. Forest Service and NOAA Lead agencies. Database and reports support Integrated Information Services.
Southern California Beach Valuation Project	Estimate the market and nonmarket economic use values and how these values change with respect to changes in user and site characteristics, especially water quality and beach closures for Los Angeles and Orange County beaches	NOS/MB/Special Projects and NOS/ORR/Damage Assessment Center	Bob Leeworthy – N/MB7 (301) 713-3000 ext. 138 Bob.Leeworthy@noaa.gov Norman Meade – N/ORR32 (301) 713-3038 ext. 201 Norman.Meade@noaa.gov	1998 – Present	Goal: Protect, restore, and manage the use of coastal and ocean resources. Cross-cutting: Sound, Reliable State-of-the-art Research	Public-Private Partnership involving two Federal agencies, two State agencies and a private NGO.

Respondent contact information: Bob Leeworthy – N/MB7, (301) 713-3000 ext. 138, Bob.Leeworthy@noaa.gov
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NOS – Special Projects, Table 2 of 3

Project Name (assign one if one doesn't exist)	**Objective and Description of Project**	**Line Office and Program** (conduction or overseeing)	**Persons Responsible and Contact Information**	**Dates of Activity**	**Applicable NOAA Mission Goal(s) or Cross-Cutting Priority**	**Comments or Additional Information**
Socioeconomic Research and Monitoring: Florida Keys National Marine Sanctuary (FKNMS) and Channel Islands National Marine Sanctuary (CINMS)	Detect and document resultant changes in sanctuary resource utilization patterns and their social and economic impacts.	NOS/MB/Special Projects/Coastal and Ocean Resource Economics Program	Bob Leeworthy – N/MB7 (301) 713-3000 ext. 138; Bob.Leeworthy@noaa.gov	FKNMS: 1998 – Present CINMS: 2002 - Present	Goal: Protect, restore, and manage the use of coastal and ocean resources. Cross-cutting: Sound, Reliable State-of-the-art Research	Workshops held with social science experts and sanctuary stakeholders to design monitoring program.
Socioeconomic Impacts of Marine Reserves: Tortugas Ecological Reserve in FKNMS and Network of Reserves in CINMS	Provide background information to establish socioeconomic framework for a study area, collect data needed to analyze impacts, assist stakeholder working groups in designing reserve alternatives, and providing objective analysis of reserve alternatives.	NOS/MB/Special Projects	Bob Leeworthy – N/MB7 (301) 713-3000 ext. 138 Bob.Leeworthy@noaa.gov	Tortugas Ecological Reserve: 1998-2001 CINMS: 1999 - Present	Goal: Protect, restore, and manage the use of coastal and ocean resources. Cross-cutting: Sound, Reliable State-of-the-art Research	Public-Private Partnership involving two Federal agencies, two State agencies and a private NGO.

Respondent contact information: Bob Leeworthy – N/MB7, (301) 713-3000 ext. 138, Bob.Leeworthy@noaa.gov
NOAA/NOS/Special Projects, 1305 East West Highway, SSMC4 9th fl, Silver Spring, MD 20910
http://marineeconomics.noaa.gov

NOS – Special Projects, Table 3 of 3

Project Name (assign one if one doesn't exist)	**Objective and Description of Project**	**Line Office and Program** (conduction or overseeing)	**Persons Responsible and Contact Information**	**Dates of Activity**	**Applicable NOAA Mission Goal(s) or Cross-Cutting Priority**	**Comments or Additional Information**
Artificial and Natural Reef Valuation: Socioeconomic Study of Reefs in Southeast Florida	Estimate market and nonmarket economic use values for artificial and natural reefs in four-county area of southeast Florida.	NOS/MB/Special Projects/Coastal and Ocean Resource Economics Program	Bob Leeworthy – N/MB7 (301) 713-3000 ext. 138; Bob.Leeworthy@noaa.gov	Survey: 2000-01 Analyses and Reports: 2002-2003	Goal: Protect, restore, and manage the use of coastal and ocean resources. Cross-cutting: Sound, Reliable State-of-the-art Research	Public-Private Partnership. NOAA, State of Florida, Palm Beach, Broward, Miami-Dade and Monroe counties, and private businesses.
National Coral Reef Valuation Study: Valuation of Hawaii's Coral Reefs	Estimate value of Hawaii's coral reefs using the total valuation approach, including use and non-use economic values using a national sample. Evaluate benefits of marine reserves.	NOS/MB/Special Projects and NOS/ORR/Damage Assessment Center	Bob Leeworthy – N/MB7 (301) 713-3000 ext. 138 Bob.Leeworthy@noaa.gov Norman Meade – N/ORR32 (301) 713-3038 ext. 201 Norman.Meade@noaa.gov	Survey Sample and Questionnaire Design: 2002-Present Survey Implementation: ?	Goal: Protect, restore, and manage the use of coastal and ocean resources. Cross-cutting: Sound, Reliable State-of-the-art Research	Funded through NOAA's Coral Reef Conservation Program. Complements project funded through Hawaii Coral Reef Initiative on economic use values of the coral reefs around Hawaii's main islands by extending valuation to Northwest Hawaiian Islands.

NOS Damage Assessment Center

Project Name (assign one if one doesn't exist)	**Objective and Description of Project**	**Line Office and Program** (conduction or overseeing)	**Persons Responsible and Contact Information**	**Dates of Activity**	**Applicable NOAA Mission Goal(s) or Cross-Cutting Priority**	**Comments or Additional Information**
Chalk Point Oil Spill: Lost Recreational Use Valuation Report	Report for the Chalk Point Oil Spill natural resource damage assessment on the economic value of recreational losses	Damage Assessment Center, NOS	Norman Meade – N/ORR32 – 301 713-3038 x 201 norman.meade@noaa.gov	Report Date: March, 2001	Goal: Protect, restore and manage the use of coastal and ocean resources	
Technical Memorandum On Lavaca Bay: Recreational Fishing Assessment	Report on a combined revealed and stated choice estimate of recreational losses for the Lavaca Bay natural resource damage assessment	Damage Assessment Center, NOS	Norman Meade – N/ORR32 – 301 713-3038 x 201 norman.meade@noaa.gov	Report Date: November, 1998	Goal: Protect, restore and manage the use of coastal and ocean resources	

The following information is the same for each listed project in this set:

1. **Persons Responsible and Contact Information:** Dr. Nancy Beller-Simms, 301-427-2089 x180, nancy.beller-simms@noaa.gov
2. **Applicable NOAA Mission Goal(s) or Cross-Cutting Priority:** Goal 2. Understand climate variability and change to enhance society's ability to plan and respond. These projects also contribute to research under the 50% rule.

OAR Office of Global Programs, Human Dimensions of Global Change Research Program

Project Name	Objective and Description of Project	Dates of Activity	Comments or Additional Information
Vulnerability Mapping **Use and Usefulness: a Comparative Study of Seasonal Climate Forecasting Systems in Drought-affected Regions of Latin America - Tim Finan (lead PI)** (Another similar example of an HDGCR project would be: Reducing the Negative Consequences of Climate Variability through the use of Forecasts and Vulnerability Analysis in Cities: The Case of Tijuana, Mexico - Roberto Sanchez (lead PI))	This project was designed to assess the socioeconomic and policy impacts of a well developed climate forecast system in the Northeast Brazilian state of Ceará, a semi-arid area particularly vulnerable to severe drought. The objectives can be summarized as follows: • To describe the policymaking process that incorporates climate information into government programs aimed at mitigating and preventing the impacts of drought or at fully taking advantage of favorable rainy seasons; • To assess the articulation between state and local levels of power in the use of climate forecast data; • To document the use of climate forecast information disseminated from FUNCEME at the level of rural stakeholders who face differential vulnerability situations; • To identify the strategies that rural families employ to mitigate drought impacts. One of the more tangible products from this study is a set of maps detailing the locations most vulnerable to drought in the area. These maps are based on extensive social science research at the community level with the region. Policy and decision makers are anxious to begin using these new tools to alleviate the desperate situations that arise in the drought years.	2000-2003	Final report and CD re: project available upon request.
Communication **Climate Change Information For Urban Policy And Decision-Making -** Roberta Miller (lead PI) (Other relevant projects: "Engaging Agricultural Communities in the Great Plains of the United States with the Applications and Developments of	This project is intended to advance scientific research and public policy by improving the communication of climate change data and information to urban policy- and decision-makers and, by so doing, to improve their capacity to respond to the impacts of climate change. It consists of research on the climate change information needs and information-seeking behavior of urban policy- and decision-makers and using this	Project began in 2002	

Climate Prediction and Information" - Steve Hu (lead PI); "Improving Climate Forecast Communications for Farm Management in Uganda" - Jennifer Phillips (lead PI))	research to construct a prototype Urban Climate Change Information System. The project will focus on the New York metropolitan area.		
Education **Development of Climate Forecasts Decision Making Teaching materials for Junior High School Teachers and Students** - Jim Mjelde (lead PI)	The focus of this study is the development and testing of teaching materials on the proper use of probabilistic forecasts in decision making for junior high school students. "The objectives of the study include development of material, which junior high school teachers can use, improved knowledge concerning climate forecasts and their use by the students, and improved comprehension and inference making by the students. Environmental education material, including climate related material developed for grade levels k-12 have focused almost exclusively on the physical sciences. Little to no materials have been developed concerning the social science aspects of environmental issues."	Beginning in 2003 (2 year project)	
Use of Forecast Information **Climatic Variations and the International Management of the North American Pacific Salmon Fishery: A Game Theoretic Perspective** - Kathy Miller (lead PI); (Other relevant projects: "Decision-Making and Long-Lead Climate Forecasts: A Case Study in Community Water System Management" - Brent Yarnal (lead PI); "Exploratory Assessment of the Potential for Improved Water Management by Increased Use of Climate Information in Three Western States" - Chuck Howe (lead PI); "Optimal Use of the Climate Prediction Center's Long-Lead Outlooks: Improved Interpretability and Decision-Analytic Case Studies" - Dan Wilks (lead PI))	This project had two complementary goals. The first was to document the impacts of environmental variability and the role of scientific information in the case of the Pacific Salmon dispute. The second was to analyze the effects of stochastic natural variability in formal game-theoretic models of shared international fisheries and, in particular, to examine the effects of varying the quality of forecast information in such a game. The results of the study were provided to policy makers and stakeholders in region. They were used by the UN Food and Agric. Organization at an international meeting on management of shared fish stocks. The PIs have been contacted and expect that the results will be used as state-of-the-art advice for future talks on shared fishery regimes and in further development of Law of the Sea re: fisheries.	1999-2003	

OAR Office of Weather and Air Quality

Project Name (assign one if one doesn't exist)	**Objective and Description of Project**	**Line Office and Program** (conduction or overseeing)	**Persons Responsible and Contact Information**	**Dates of Activity**	**Applicable NOAA Mission Goal(s) or Cross-Cutting Priority**	**Comments or Additional Information**
Societal Impact Project (SIP) for the US Weather Research Program (USWRP) and THORPEX	Research in support of weather forecast improvements from short to medium range.	OAR/Office of Weather and Air Quality	SIP Director (NCAR) – TDP (around first of the calendar year) NOAA Contacts: Pai-Yei Whung (THORPEX focus) John Gaynor (USWRP focus)	Beginning approx. Jan. 1, 2004 with no end date.	Serve society's needs for weather and water information.	The US component of THORPEX is under the auspices of the USWRP. The SIP will be positioned to initially focus on THORPEX societal and economic impact issues. It will be critical to align the SIP to NOAA's SI needs as much as possible and to blend the needs for medium and extended range forecasts with those for sub-seasonal and seasonal forecasts.
NE Energy Pilot Project	Engage energy sector on NOAA weather, climate and air quality forecasting information and, the requirements for improving NOAA weather, climate and air quality products and services.	Office of Weather and Air Quality	NOAA Contact: Pai-Yei Whung	The final report is going through review right now.	Mission Goal Team #3 Weather and Water	There are four reports commissioned by NOAA on Energy and Environmental Information. The reports provide information on how the energy sector use the Environmental Information for their operational planning.

Chief Economist, PPI

Project Name (assign one if one doesn't exist)	**Objective and Description of Project**	**Line Office and Program** (conduction or overseeing)	**Persons Responsible and Contact Information**	**Dates of Activity**	**Applicable NOAA Mission Goal(s) or Cross-Cutting Priority**	**Comments or Additional Information**
Economic Benefits of ENSO Forecasts	Assess and quantify economic benefits of ENSO forecasts in various sectors (agriculture, energy, fisheries, etc)	PPI Funded by NOS, NWS, NESDIS	Rodney Weiher in conjunction with various academic and research economist and interdisciplinary scientists.	1995-present	Weather/Water, Climate, Observations, Research	Published in various journals and NOAA/DOC *Improving El Nino Forecasting: The Potential Economic Benefits*, Aug., 1999
Economics of Ocean Observing Systems	Assess and quantify economic rational for observing systems and quantify benefits across sectors and users	PPI Jointly funded by Navy and NOAA	Rodney Weiher in conjunction with various academic and research economists and interdisciplinary scientists.	1995-present	All Mission Goals, Observation and Research Council	Compendium of work in NOAA/DOC *The Economics of ISOOS: Benefits and Rationale for Public Funding*
Economic Benefits of Coastal Ocean Observing Systems	Identify and quantify economic benefits of US regional observing systems	PPI Funded by NOAA and NOPP agencies	Hauke Kite-Powell, WHOI Marine Policy Center PI; Rodney Weiher, project manager	2002- present	All Mission Goals, Observation and Research Councils	Phase one completed March 2004; final report in September.
Economic benefits of weather forecasting and weather/climate information	Quantify benefits in: 1) electricity generation 2) urban heat wave warnings 3) space weather 4) US household sector 5) hurricanes 6) drought 7) snow	PPI Funding provided by NWS, NESDIS (NPOESS)	Rodney Weiher in conjunction with academic and research economists and interdisciplinary scientists	1997-present	Weather-water, Climate, Research and Observations Councils	Published papers, seminars. Several projects underway

Modernizing Russian Hydromet	Assist Russian Hydromet and World Bank with advice on estimating economic benefits and investment strategies	PPI and NWS/ International	Rodney Weiher with assistance of outside academic and research economists	2003-present	Weather-water; Climate; Observation Council	Providing technical advice on economic aspects of modernizing Russian Hydromet
Economics for State & Local Coastal and Marine Planners and Managers	Regional workshops for non-economists on using economic tools like C/B analysis and non-market benefit analysis for coastal management	PPI Funding provides by NOS, NMFS, OAR	Rodney Weiher and Doug Lipton (University of Maryland)	1995-present	Ecosystems and Research Council	Workshops for coastal and marine managers in response to their growing requirements to use economics in management process.
Economics for Regional Coastal Resource Management	Workbooks on economic concepts and tools tailored for management at regional levels, e.g. Great Lakes, Florida, New England	PPI Funding provided by NOS, NMFS, OAR	Rodney Weiher and Doug Lipton in collaboration with research institutes and academic research economists	1997-present	Ecosystems and Research Council	Panels formed with key resource economists in each region; Handbooks published for Great Lakes and Florida

Examples of Use of Social Science Outside of NOAA

A Myrick Freeman III, "Environmental Policy Since Earth Day1: What Have We Gained?," *Journal of Economic Perspectives* (Winter 2002), pp. 125-146.

> Freeman examines the experience with environmental policy since the passage of the Clean Air Act and establishment of the Environmental Protection Agency in 1970 and the passage of the Clean Water Act in 1992. In evaluating methodological considerations in a progression of cost-benefit studies he finds mixed results for the record of policy payoffs, the reliance on cost-benefit studies and how well the studies were performed.
>
> To improve cost-effectiveness he recommends replacing command and control policy instruments with market-based incentives, targeting regulation and standards more to programs with relatively high cost-effectiveness and giving more weight to comparisons of benefits and costs in making environmental choices.

Brock, William A., and Anastasios Xepapadeas, "Valuing Biodiversity from and Economic Perspective," *American Economic Review* (December 2003), pp.1597-1614.

> Focusing on crop mix dynamics, Brock and Xepapadeas use an approach of valuing biodiversity "*not* based on genetic distances but in terms of the value of characteristics or services that an ecosystem provides or enhances when managed optimally,…In this example optimal management of crop diversity involves trading off the gains from specialization to the most desirable crop today against facing a less desirable gene pool of threats to the system as a whole tomorrow. (p.1598) The approach leads to insights into "which models need to be built of which parts of the ecosystem, which parameters need to be measured, and which uncertainties are most worthwhile to resolve,…" (p.1599)

Smith, V. Kerry, *et. al*., "General Equilibrium Estimates for Environmental Improvements: Projected Ozone Reductions for the Los Angeles Air Basin," forthcoming in *Journal of Environmental Economics and Management* http://www.nber.org/books/environment5-02/index.html

> Smith and his colleagues model a way of measuring benefits of the Clean Air Act that takes into account the adjustments in location people make to changes in air quality conditions as well as the initial impacts of the changes. The research examines counties and school districts. Taking

into account adjustments, policies have a significant effect on willingness to pay for improved ozone concentrations.

Royal Swedish Academy of Sciences, "Foundations of Behavioral Economics: Daniel Kahneman and Vernon Smith," *Advanced Information o the Prize in Economic Sciences* (December 17, 2002).

Psychology has made important contributions to understanding and measurement of behavioral issues that have been the province of economists. This is reflected in the awarding of the Nobel Prize in economics to Daniel Kahneman and in the groundbreaking work of Kahneman and others. (The article also discusses Smith's contribution to experimental economics.)

Behavioral economics deals with decision-making under uncertainty, considering complex situations where economic assumptions of rationality may not apply. Situations examined include those where individuals misperceive the odds of occurrences because they do not understand the statistical "law of large numbers" and prospect theory, which addresses how people compare alternatives and respond to the prospects of loss vs. gain.

Podolny, Joel, "A Picture Is Worth a Thousand Symbols: A Sociologists View of the Economic Pursuit of Truth," American Economic Review (May 2003), pp.169-174.

Podolny discusses the capacity of visual images to display truth about the social world. He notes distinctions between different types of iconic signs — images, diagrams and metaphors, and illustrates the use of visual images of social topography in analyzing social capital and social distance. He goes on to consider the use of images in examining the nature of alliances of firms in a network, segmentation in labor markets and models of segregation.

Polinsky, A. Mitchell, and Steven Shavell, "The Economic Theory of Public Law Enforcement," *Journal of Economic Literature* (March 2000), pp.45-76.

Polinsky and Shavell present an economic theory of public enforcement of law that answers questions of how much of society's resources should be devoted to apprehending violators, what kinds of sanctions should there be and at what level should sanctions be set. Attention is given to implications of uncertainty and imperfect knowledge. The analysis is applicable to enforcement of environmental restrictions as well as to many other issues.

Economic Methods

Some Economics Concepts and Tools

Utility

A subjective measure of the satisfaction derived from consumption of a good or service or presence of a condition (such as an attractive environment).

Public good

A good that cannot be charged for in relation to use (like the view of a park or survival of a species), so there is no incentive to produce or maintain the good. A public good can be used by many people without being used up and is available at no or negligible additional cost as the number of users increases. Public goods, by their nature are typically provided by governments and sometimes by philanthropy or protected by regulation.

Opportunity cost

The value of the use of resources in an alternative way that is not obtained when the resources are used in the current way.

Average vs. marginal cost

Average cost – cost per unit of output (an output can be information or a service rather than just a physical product)
Marginal cost – additional cost of producing and additional unit of output

Economies of scope and scale

Economies of scope – changes in unit cost associated with changing the number of products of attributes

Economies of scale – changes in unit cost associated with increasing the number of units produced. Can apply to the size of an industry or region as well.

Joint production

Production of two or more products simultaneously using some of the same resources. Allocation of costs is ambiguous when joint production occurs, and rules of thumb are often used.

Externalities

Changes in costs or benefits to one person or sector resulting from changes in conditions in another.

Network externalities/economies

Efficiencies arising from the participation of individuals or organizations in a network. (Diseconomies could arise, for example, with congestion costs.)

Induced innovation

Innovation that comes in response to economic incentives. Incentives can take the form of higher costs that lead to the search for savings though development of technology or improved organization, growing markets that increase the rate of return to investments in innovations that make it possible to serve those markets, reductions in the costs of technology that encourage their use, regulations that create interest in meeting requirements in less onerous ways, etc.

Elasticity

The percentage change in one variable for each one percent change in another variable to which it responds. For example, the price elasticity of demand is the percentage change in demand associated with a one percent change in price.

Value of time

The resource value of the use of people's time in carrying out an activity. Activities that are not paid for but require time such as traveling or participating in regulatory processes can be valued in relation to the wages that could have been earned or the utility (opportunity cost) that could have been obtained by engaging in another activity.

Time preference/time value of money

The amount of money a person has to be paid to forego income today in favor of receiving income at a later date. This is a measure of individual or organizational preference. Generally it is valued by an interest rate that could be earned on the money while waiting. The concept is used in investment analysis, including in valuing investments in infrastructure and in a better environment.

Human capital

The stock of ability and knowledge that reflects the accumulated value of information and all forms of education.

"All other things being equal"

Changes that would have been observed if no other changes occurred at the same time. The concept is used to indicate isolation of influences of particular actions or developments that are of interest. There also can, of course, be interaction effects that occur because other changes have taken place.

Valuation

Valuation can be based on:

What people or organizations pay

> Observed prices
> Payment by people with differing strengths of demand (consumer surplus)

Willingness to pay as gauged by surveys

> Direct questions
> Willingness to pay for particular attributes (timeliness, convenience, etc)

Value of activities or products the product contributes to

Value of time in shopping and using a product (lost use of the time in other pursuits such as working)

Value of health and life — as gauged by loss of earnings, medical costs and what people have to be paid to take dangerous jobs

Contribution to the output or productivity of a consuming organization or system

Utility derived by the public — i.e. for a public good that is not used up and has a very low additional cost of being available to many more users

> Utility of a public good sometimes can be gauged by loss of an alternative use (e.g. not selling park land or not collecting taxes on its use)

Valuation takes into account both present and future effects, allowing for a promise of a dollar to be received later being worth less than a dollar received today (discounting).

Cost-Benefit and Cost-Effectiveness Analysis

Approach

Cost-effectiveness analysis relates cost to a measure of output or outcome

Cost-benefit analysis relates cost to the value of the output or outcome

Cost-effectiveness is often used when valuation measures are not easily obtainable or differences over methods exist.

Uses of cost-benefit analysis:

- Justifying program expenditures
  - Size if impacted sectors
  - Benefits
  - Benefits in relation to costs and/or effectiveness
- Making choices among programs and deciding how much to spend or invest
  - Choosing among programs for alternative goals or for the same goals
  - Taking into account how payoff varies with scale
  - Determining contributions of complementary inputs or programs
- Designing programs
  - Features of products, target users and uses and distribution systems
- Defining public/privates sector roles

Cost-benefit and cost-effectiveness analyses provide an information system that illuminates and informs the decision-making process. They offer a framework for organizing thoughts, listing the pros and cons of alternatives, and determining values for all relevant factors so that the alternatives can be ranked.

They are not a mechanical process that determines policy or action, substituting for a political or other process that can take other considerations into account.

Cost-Benefit Analysis as a Method of Integrating Analyses and Presenting Results

Cost-benefit analysis can serve as a method of integrating many kinds of analysis and a form of presentation, making use of:

Benefits based on:
- Demand and market penetration
- Adaptation to information
- Who uses and who benefits
- Valuation of information

Costs based on:
- Technology
- Competition; contract and employee incentives
- Economies of scale, scope, learning or network

What is a cost vs. a benefit depends on to whom.

Cost-Benefit Elements

Market benefits

- Short term vs. long term benefits
- Direct and indirect benefits
- System effects

Non-market benefits

Public goods

- If difficult to exclude users who do not pay
- If the product can be provided to additional users at essentially zero incremental cost

Valuation of benefits can include

- Value of information
- Value of reducing uncertainty
- Value of people's time
- Value in conjunction with other inputs or products

Cost

- Marginal (incremental) vs. average costs
- Direct and indirect costs
- Non-market costs

Dealing With Joint Benefits and Costs of Multiple Inputs or Products

Some programs use inputs from several sources and/or produce outputs only in combination (e.g. data and forecasts). In these circumstances it is necessary to allocate the benefits and costs among programs for the individual program performances to be assessed.

The techniques available to allocate benefits and costs among programs yield only approximations. Sometimes a simple rule of thumb like allocating benefits in proportion to costs can be used, especially if the result is to be added to information on other programs that are part of a set of activities. However, caution must be used in basing decisions on the assumptions that crude allocations require.

	multiple inputs	**multiple outputs**
benefits	• First determine the combined benefits • If possible, estimate incremental benefits for each of the inputs • Allocate total benefits based on the relative sizes of the incremental benefits of each input Alternatively, use a rule of thumb based on a historical allocation or allocations in other circumstances or rely on negotiation	• First determine the combined benefits • If possible, estimate incremental benefits for each of the outputs • Allocate total benefits based on the relative sizes of the incremental benefits of each output Alternatively, use a rule of thumb based on a historical allocation or allocations in other circumstances or rely on negotiation
costs	• First determine the combined costs • If possible, estimate incremental costs for each of the inputs • Allocate total costs based on the relative sizes of the incremental costs of each input Alternatively, use a rule of thumb based on a historical allocation or allocations in other circumstances or rely on negotiation	• First determine the combined costs • If possible, estimate incremental costs for each of the outputs • Allocate total costs based on the relative sizes of the incremental costs of each output Alternatively, use a rule of thumb based on a historical allocation or allocations in other circumstances or rely on negotiation

Incremental = associated with having an additional unit of the input or output

NOAA Social Scientists

NOAA Social Scientists as of 2003

With the exception of NMFS, and to a much lesser extent NOS, there are few FTE's working as social scientists in NOAA:

NESDIS	None
NWS	None
OAR program	3 FTE in OGP administering Economics and Human Dimensions
PPI	One
NOS	6 Economists--Damage Assessment Center (litigation sensitive) 3 Economists--Two in Special Projects (recreation surveys); one Sanctuaries
NMFS[1] Act	38 Economists, 31 of which are in the field, working on Magnuson National Standards for Fishery Management Plans, which triggers Executive Order 12866 (Cost Benefit Analysis of Major Regulations), Regulatory Flexibility Act (Small Business), NEPA, ESA, and MMPA.
Community	11 Anthropologists and sociologist in the field, working on Impact Statements for Magnuson Act (community profiling, demographics, etc.)

[1]NMFS has identified 140 social scientists as 100% of requirements verses 49 on-board.

Attendees at Discussions Among NOAA Social Scientists

Nancy Beller-Simms	OGP
Leah Bunce	NOS/International
Amy Buss-Gautham	NMFS/HQTR
Rita Curtis	NMFS/HQTR
Josh Foster	PPI/HQTR
Peter Fricke	NMFS/HQTR
John Gaynor	OAR/USWRP
Harvey Hill	OGP
Chester J. Koblinsky	OAR/EXEC
Bob Leeworthy	NOS/special projects
Irving Leveson	consultant on soc. sci. integration
Douglas Lipton	Univ. of Maryland
Robert E. Livezey	NWS/HQTR
Norman Meade	NOS/HQTR
Betsy Nicholson	NOS
Claudia Nierenberg	OAR/HQTR
Caitlin Simpson	OAR/HQTR
Rodney Weiher	PPI/HQTR
Pai-Yei Whung	PA&E

Presenters at Social Science Workshops

NOAA

Nancy Beller-Simms	Office of global Programs
Rita Curtis	NMFS
Harvey Hill	Office of Global Programs
Bob Leeworthy	NOS
Norman Meade	NOS

Consultants

Name	Affiliation
Richard Adams	Oregon State Univ.
James Boyd	Resources for the Future
Charles Colgan	Univ. of Maine Muske Policy Center
Hauke Kite-Powell	Woods Hole Marine Policy Center
Jeffrey Lazo	NCAR
David Letson	Univ. of Miami
Irving Leveson	social science program consultant; ForecastCenter.com and Hudson Inst.
Douglas Lipton	Univ. of Maryland; Dir. Sea Grant Ext.
Thomas Teisberg	Charlottesville

Members of the NOAA Social Sciences Advisory Panel

Issuing the March 18, 2003 Final Report

to the NOAA Science Advisory Board

Lee G. Anderson
University of Delaware

Richard Bishop
University of Wisconsin

Margaret Davidson
NOAA NOS

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Oregon State University

Mark Holliday
NOAA NMFS

Judith Kildow
University of Southern California

Diana Liverman
University of Arizona

Bonnie J. McCay
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Edward L. Miles
University of Washington

Roger Pielke, Jr.
University of Colorado

Roger Pulwarty
NOAA OAR OGP CDC

Consultation

- NOAA Leadership
- Research Council
- Science Advisory Board
- Social Science Panel
- PPI
- PA&E
- Mission goal teams
- Program managers
- Ad hoc group of NOAA social scientists
- Advisory panel of consultants

References

Adams, R., *et. al.*, *The Economics of Sustained Ocean Observing: Benefits and Rationale for Public Funding*, Washington, D.C.: NOAA and Office of Naval Research, 2000.

Brock, William, and Anastasios Xepapadeos, "Valueing Biodiversity from and Economic Perspective," *American Economic Review* (December 2003), pp.1597-1614.

Brown, T.J., H.L. Beth, and A.L. Westerling, "The Impact of Twenty-First Century Climate Change on Wildland Fire Danger in the Western United States: An Applications Perspective," *Climate Change* (2000), pp.365-388.

Bunce, L., *et. al.*, *Socioeconomic Manual for Coral Reef Management*," Global Coral Reef Monitoring Network, Australian Institute of Marine Science, 2000.

Carson, Richard T., *et. al.*, "Was the NOAA Panel Correct about Contingent Valuation," Discussion Paper 96-20, Resources for the Future, May 1996.

Colgan, Charles S., and Rodney Weiher, "Linking Economic and Environmental Goals in NOAA Strategic Planning," September 26, 2002
http://www.ppi.noaa.gov/social_economics.htm

Duraiappah, Anantha K., "Poverty and Environmental Degradation: A Review and Analysis of the Nexus," *World Development* (1998), No. 12, pp.2169-2179.

Freeman III, A. Myrick, "Environmental Policy Since Earth Day 1: What Have We Gained," *Economic Perspectives* (Winter 2002) pp.125-146.

Hoagland, Porter and Kimberly Murray, "Issues in Assessing the Benefits of NPOESS for the Detection of Harmful Algae Blooms or their Precursors," Marine Policy Center, Woods Hole Oceanographic Institution, January 2002.

Hudson Institute, *Hudson Trend Analysis*, September 2002
http://www.spo.noaa.gov/publications.htm

Kahneman, Daniel, "Maps of Bounded Rationality: Psychology for Behavioral Economics," *American Economic Review* (December 2003), pp.1449-1475.

Kahneman, Daniel, "A Psychological Perspective on Economics," *American Economic Review* (May 2003), pp.162-168.

Kite-Powell, H. L., "Benefits of NPOESS for Commercial Aviation — Volcanic Ash Avoidance," Marine Policy Center, Woods Hole Oceanographic Institution, January 2001.

Kite-Powell, H. L., "Benefits of NPOESS for Commercial Ship Routing — Transit Time Savings," WHOI report to NOAA, 2000.

Kite-Powell,, H.L., and C.S. Colgan, "Economics of an Integrated Ocean Observing System," *Marine Technology Society Journal* 37(3), pp.55-66.

Kite-Powell,, H.L., and C.S. Colgan, "The Potential Economic Benefits of Coastal Observing Systems: the Gulf of Maine," NOAA/ONR/WHOI joint publication, 2001.

Lazo, Jeffrey K., "What Are Weather Forecasts Worth?," slides, Stratus Consulting, Inc., January 30, 2004.

Letson, David, and J. Walter Milon, *Florida Coastal Environmental Resources: A Guide to Economic Valuation and Impact Analysis*, Florida Sea Grant College Program, University of Florida, 2002.

List, John A., "Substitutability, Experience, and the Value Disparity: Evidence from the Marketplace," Department of Agricultural and Resource Economics, University of Maryland, June 28, 2002 http://www.nber.org/books/environment5-02/index.html

National Marine Fisheries Service, NOAA, "Guidelines for Assessment of the Social Impact of Fishery Management Actions," *NMFS Operational Guidelines – Fisheries Management Process, Appendix 2(g),* revised March 19,2 001.

NOAA, *Economic Statistics for NOAA*, March 2003
http://www.ppi.noaa.gov/social_economics.htm

NOAA, *Geostationary Operational Environmental Satellite System (GOES): GOES-R Sounder and Imager Cost/Benefit Analysis*, NESDIS Office of Systems Development, November 15, 2002.

NOAA, *New Priorities for the 21st Century: NOAA's Strategic Vision*, n.d.

NOAA Office of Global Programs, *Regional Integrated Sciences and Assessments Program (RISA) FY2004*, n.d.

NOAA Social Science Review Panel, *Final Report to the NOAA Science Advisory Board*, March 18, 2003.

NOAA/OAR Office of Global Programs, *Background Papers in Preparation for "Insights and Tools for Adaptation: Learning from Climate Variability,"* Washington, D.C., November 18-20, 2003.

Podolny, Joel, "A Picture Is Worth a Thousand Symbols: A Sociologists View of the Economic Pursuit of Truth," American Economic Review (May 2003), pp.169-174.

Polinsky, A. Mitchell, and Steven Shavell, "The Economic Theory of Public Law Enforcement," *Journal of Economic Literature* (March 2000), pp.45-76.

Royal Swedish Academy of Sciences, "Foundations of Behavioral Economics: Daniel Kahneman and Vernon Smith," Advanced Information o the Prize in Economic Sciences (December 17, 2002).

Smith, V. Kerry, *et. al.*, "General Equillibrium Benefit Estimates for Environmental Improvements: Projected Ozone Reductions for the Los Angeles Air Basin," paper presented and the National Bureau of Economic Research conference on Environmental Economics, May 17-18, 2002, revised March 12, 2003 http://www.nber.org/books/environment5-02/index.html

Teisberg, Thomas J., "The Value of Information Regarding Climate Change," April 24, 2002.

Teisberg, Thomas J., and Rodney F. Weiher, "Valuation of Geomagnetic Storm Forecasts: an Estimate of the Net Economic Benefits of a Satellite Warning System," *Insights*, pp. 329-334, n.d.

Weiher, Rodney F., editor, *Improving El Niño Forecasting: The Potential Economic Benefits*, NOAA Office of Policy and Strategic Planning, n.d.

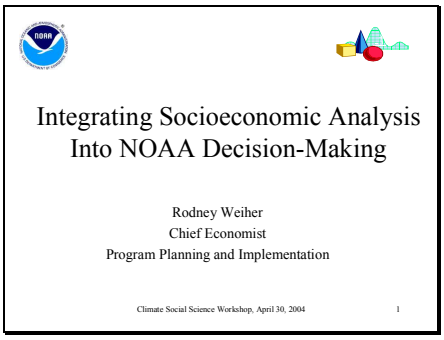
Weiher, Rodney, Charles S. Colgan and Thomas Teisberg, "Using Economics in NOAA Performance Measures: The Role of Economic Performance Measures in GRPA,' April 2002 http://www.ppi.noaa.gov/social_economics.htm

Additional references appear in some of the slide presentations.

Part 2: Speaker Slides

Integrating Socioeconomic Analysis Into NOAA Decision - Making
Rodney F. Weiher

Slide 1



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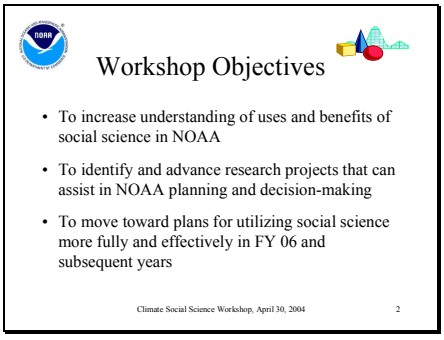

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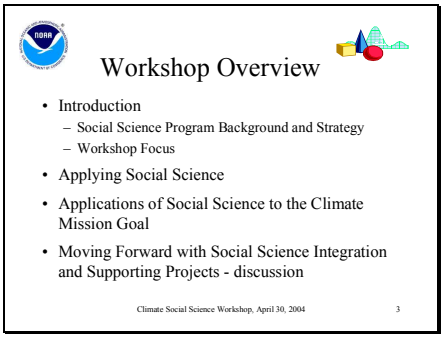


Slide 4

Social Science Program Background and Strategy

Slide 5

SAB Social Science Report

- Concluded:
  - NOAA's capacity to meet mandates and missions is diminished by under-representation and underutilization of social sciences.
- Recommended:
  - Improved social science literacy at all levels in NOAA
  - Develop research strategies, plans, and programs
  - Integrate into management structure (SP, PA&E, PPI)

Slide 6

Research Council

Research Council charged with oversight and recommending steps to implement the Report, including:

1. Workshops on uses and benefits of social science for AA/Mission Goal Teams and selected program level workshops and DOC
2. Concurrently, develop focused pilot projects to demonstrate utility in '04-'05
3. Develop social science component in each Mission Goal for '06
4. Develop 5-year Plans and Strategies

Slide 7

Baseline Assessment

"Incorporating social sciences into NOAA recognized as important but less than 15% of the programs noted socioeconomics in their PBA desired outcomes, capabilities, or capacities"

"Only half of the programs are aware of socioeconomic benefits of their program and, only 3 programs noted social science research in their alternatives to address deficiencies"

From PA&E FY06-FY10 Baseline Assessment slides, November 6, 2003

Slide 8

Social Science Program Guidance

"PPI will develop an approach for determining how to identify social science research requirements and work with the goal team leads to ensure social science requirements are considered in the development of program plans."

"Establish a core social science team to improve NOAA's ability to articulate socioeconomic values of products and services and to incorporate into decision-making."

From FY 06 Programming and Fiscal Guidance - Serial 7

Slide 9

Consultation

- NOAA leadership
- Research Council
- SAB
- Social Science Panel
- PPI
- PA&E
- Mission goal teams
- Program managers
- Ad hoc group of NOAA social scientists
- Advisory panel of consultants

Slide 10

FY 04 and FY 05 Buildup to FY 06 -FY 10 Program

- Coordinating social scientists through regular meetings and contacts
- Workshops with goal team leads, AAs, NOAA leadership and Department of Commerce
- Developing program guidance and research programs and plans for NOAA-wide programs and mission goals
- Inventorying existing activities
- Pilot projects and initial research
- Disseminating successful examples

Slide 11

Workshop Focus

Slide 12

Climate Program Guidance

(Serial 7)

Define the requirement for expanded products and services, including identification of customers and their needs, and assess the program's ability to deliver these products and services within the current program.

Slide 13

Emphasis on Examples

The workshops focus on examples of social science use for practical problems facing each mission goal.

Particular attention is given to each mission goal's less well-covered and newer areas of activity.

Slide 14

Social Science Can Help You

- Determine the value of programs and demonstrate it to others
- Decide which programs to support based on documented payoffs
- Measure program performance in ways that better reflect inputs and costs
- Make choices among services, uses and distribution
- Plan investments in physical and human resources
- Assess interrelated programs and understand what groups of programs add up to
- Avoid unintended consequences
- Develop targeted information systems
- Promote longer term thinking and planning for initiatives with substantial lead times or long payoff periods

Slide 15

Examples of Uses of Each Social Science

- **Economics**
  - Estimating demands for services
  - Determining benefits and costs to individuals and society
- **Sociology and Anthropology**
  - Understanding changes in communities in response to resource management programs and environmental change
  - Assessing human impacts of changes in climate and environment
- **Demography**
  - Understanding population changes that could impact the environment
- **Geography**
  - Defining boundaries of ecosystems and affected populations
- **Psychology**
  - Assessing perceptions of NOAA services
  - Estimating demands for services
- **Political Science**
  - Analyzing pressures for programs and reactions to programs and regulations
  - Understanding governance structures

Slide 16

Agenda for Discussion

- How would you use social science for *this* mission goal
  - In defining markets or ecosystems, anticipating impacts of policies, designing programs, measuring outcomes, valuing benefits, etc.
- In what areas is social science needed
  - The subject is a priority
  - Social science can make a contribution it is not now making
  - There are benefits to the use across NOAA
- What projects would you suggest to fill those needs?
  - Subject, objective and scope for each project
  - How are they related to what has been done or is underway and to what has been newly authorized or funded?
  - What is needed to get them going?

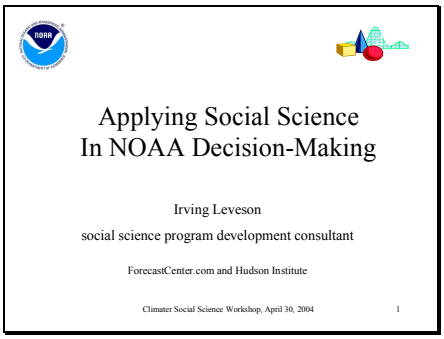
Slide 17

Components of an Economics Research Strategy

- "Footprint" analysis--user sectors, scale of economic activity, high value product/user combinations
- "Forces & Trends" analysis--new technologies, behavior of users and systems, trends, challenges
- Public/private roles and models
- Case/pilot studies--cost/benefit analysis

Applying Social Science in NOAA Decision-Making – Irv Leveson

Slide 1



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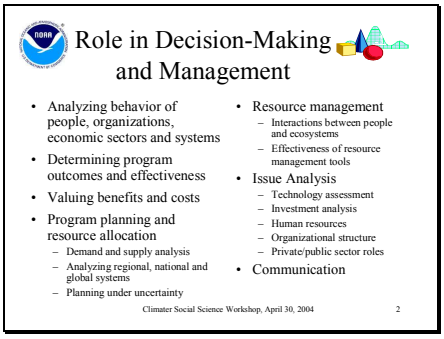

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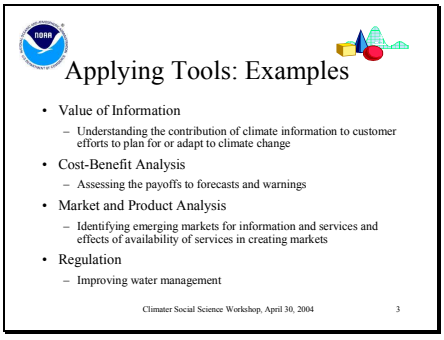


Slide 4

Applying Tools (concl.)

- Surveys
  - Estimating willingness to pay for more more localized information
  - Measuring how customers and their constituents respond to information
- Dealing with uncertainty
  - Understanding effects of forecast uncertainty on use and benefits from use
  - Damage assessment
- Defining data
  - Making effective use of data that global observing systems will generate
  - Tailoring products to markets, users and uses
- Defining performance measures
  - Understanding how information on carbon cycle and aerosols is used
  - Defining health and environmental effects and ways of determining them

Slide 5

Knowledge for Planning at Every Stage of Activity

Stage of activity planned
- Infrastructure, product support and maintenance
- Observation and assimilation
- Analysis and prediction
- Dissemination and decision support

→

Analysis for determining:
- Product and service attributes
- Size and behavior of markets
- Users and ultimate beneficiaries
- Uses and benefits
- Distribution systems
- Human and physical resource requirements and costs
- Role of the private sector

Slide 6

Uses of Cost-Benefit Analysis

- Justifying program expenditures
  - Size of impacted sectors
  - Benefits; benefits in relation to costs and/or effectiveness
- Making choices among programs and deciding how much to spend or invest
  - Choosing among programs for alternative goals or the same goals
  - Taking into account how payoff varies with scale
  - Determining contributions of complementary inputs or programs
- Designing programs
  - Features of products, target users and uses and distribution systems
- Defining public/private sector roles

Slide 7

Cost-Benefit Elements

- Market benefits
  - Short term vs. long term benefits
  - Direct and indirect benefits
  - System effects
- Non-market benefits
  - Public goods
    - If difficult to exclude users who do not pay
    - If the product can be provided to additional users at essentially zero incremental cost
  - Non-market valuation
- Valuation of benefits
  - Value of information
  - Value of reducing uncertainty
  - Value of people's time
  - Value in conjunction with other inputs or products
- Cost
  - Marginal (incremental) vs. average costs
  - Direct and indirect costs
  - Non-market costs

Slide 8

A Method of Integrating Analyses and a Method of Presentation

- Benefits based on:
  - Demand, uses and users
  - Adaptation to information
  - Who benefits
  - Valuation information
- Costs based on:
  - Technology
  - Competition; contract and employee incentives
  - Economies of scale, scope, learning and network

Slide 9

Impacts and Valuations Can Be Gauged from

- Actual events
  - Before and after comparisons of outcomes
  - Comparisons among areas or subjects experiencing different levels of effects
- Behavior such as changes in activity in response to information/forecasts or buying insurance
- Surveys to elicit views of people and organizations
- Modeling to deal with multiple sources of change

Slide 10

Using Social Science in Developing Performance Measures

- Determining what measures to use and how to define them
- Understanding how people and organizations may respond to programs in order to know what effects to look for and in which settings to look for them
- Using survey and other methods to collect performance data
- Understanding perceptions of changes that may influence how information is reported
- Developing predictions of outcomes in the absence of programs for comparison
- Using models to estimate effects of programs with other things held constant
- Understanding how programs may interact and how to deal with combined effects
- Developing performance measures consistent with measures of valuation and cost

Slide 11

Ray Kurzweil's 3 Steps for Beginning the Invention Process

- Write the advertising brochure
  - It compels you to list the features, the benefits and the beneficiaries
- Recruit the intended users
  - If they don't immediately get excited then you are probably headed down the primrose path. Invite them to participate in creating the invention
- Engage in some fantasy
  - Imagine giving a future speech about how you solved the problems underlying the invention. What would you have to be saying. Work backwards from there

Slide 12

Incipient Markets

- Markets may be created by offering a product
  - Potential users may not recognize their interest until they try to use the product
- The value of the product may require developing a critical mass of users
  - Initial specialized users or early adopters may not be typical of the broader market
- The market may be smaller if the data is not real time, but value to users or the public may be great
- It may be necessary to evaluate collections of products and/or the simultaneous use of several products by a user

Slide 13

New Product Analysis

- Decisions to proceed with product development may have to be made before there is much outside information on how products will be received or used
  - Adaptive planning: When cost-benefit analysis cannot yet be applied systematically, it may be necessary to get started in stages, evaluating the results at each stage and modifying programs as experience is gained
- Investing in developing information can be essential even when the information will be available too late for current decisions
  - The same issues will continue to arise with the present program and with other programs
  - A basis for gauging effects of initiatives will be needed

Slide 14

Product Analysis (concl.)

- The use and value of some climate products may be very scenario-dependent
- Scenarios may have to deal with:
  - The pace and nature of climate change
  - Responses to expected or actual climate change by government agencies, industries and the public
  - Responses (policies, activities) of the parties to the availability of the climate products under the scenario conditions

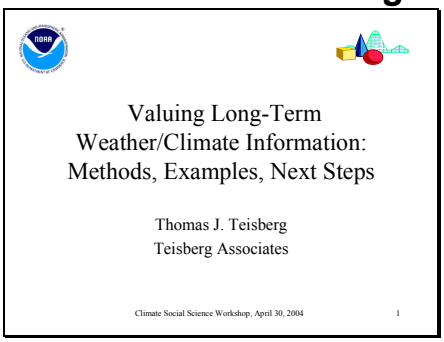
Slide 15

Considerations in Public and Private Sector Roles

- Importance of the information for public purposes
- Incremental cost of public production
- Incentive of private sector to develop
- Timing and completeness of private coverage
- Competitiveness of private sector pricing
- Comparing public vs. private provision with regard to:
  - Continuity of service
  - Ability to keep up with technology
  - Ability to finance
- Opportunities for public-private partnership and cooperation

Valuing Long-Term Weather/Climate Information: Methods, Examples, Next Steps – Thomas J. Teisberg

Slide 1



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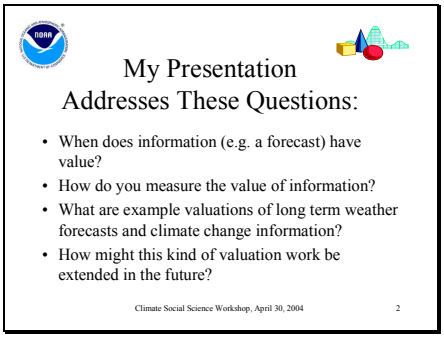

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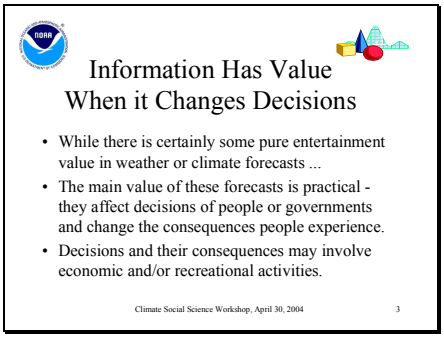


Slide 4

At Least 10% of GDP is Affected by Weather

- Agriculture ($80 billion)
- Air transportation ($88 billion)
- Construction activities ($373 billion)
- Electricity generation ($220 billion)
- Fisheries ($4 billion)
- Outdoor recreation ($100 billion)
- Storm damage mitigation and repair ($17 billion)
- Human health and life

Slide 5

To Value Information, Focus on Decisions and Consequences

- Identify decisions that are (or could be) improved using a reliable forecast.
- Value economic consequences, when the best decisions are made (1) with a weather forecast and (2) without a forecast.
- Difference between values with and without a forecast is the net value of the forecast.

Slide 6

Some Progress in Valuing ENSO Forecasts

- Solow, et. al., "The Value of Improved ENSO Prediction to US Agriculture"
- Crop storage*
- Fishery management*
- Water resource management (exploratory work)*
- Natural gas storage (exploratory work)*

*involves storage decisions

Slide 7

The Value of Improved ENSO Prediction to US Agriculture

- ENSO states (weather):
  W_1 = El Nino (frequency = 23%)
  W_2 = El Viejo (frequency = 30%)
  W_3 = Normal (frequency = 47%)
- Each ENSO state implies different temperature and precipitation conditions.
- The best crop planting decision (D) depends on the temperature and precipitation.

Slide 8

Need Models of Decisions and Consequences

- Erosion Productivity Impact Calculator (EPIC) is a model that predicts yields, given a crop choice and weather data:
  Y = EPIC(D,W)
- Agricultural Sector Model (ASM) calculates economic value realized, given yields:
  V = ASM(Y)
- Implies: V = ASM[EPIC(D,W)]

Slide 9

No Forecast Case: Make One Decision

- Choose one decision, D, to maximize expected value realized (over possible values of W)

$$E(V) = \sum ASM[EPIC(D,W)] \times Prob(W)$$

- Result is V_{NF}

Slide 10

Forecast Case: Make Three Decisions

- Possible forecasts: W= El Nino, W= El Viejo, W= Normal (assume perfect)
- For each possible forecast, W_i , choose a decision, D_i , that maximizes $V_i = ASM[EPIC(D_i, W_i)]$
- D_i will be different for each W_i
- Consequences will be different too: V_1 , V_2 , V_3
- Average V_i to get the value with a forecast: V_F

Slide 11

Bottom Line: Value of Forecast is Difference

- The value of forecasts is V_F - V_{NF}.
- In the US agriculture study, the value of a perfect ENSO forecast was estimated to be $323 million per year.
- For more modest skill (60% chance of correct prediction), value was $240 million per year.

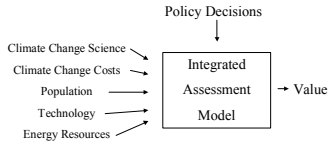
Slide 12

Climate Change Information Drives Government Decisions

- Long term climate change forecasts would mainly affect policy decisions of governments around the world.
- These policy decisions would in turn affect economic outcomes and non-economic outcomes (e.g. ecological damage) for people worldwide, over decades to centuries.
- This is a very complicated system!

Slide 13

Use IA Model for Decisions and Consequences



Climate Social Science Workshop, April 30, 2004 13

Slide 14

The Valuation Technique is the Same

- Integrated Assessment Model can (at least in principle) give values for decisions made and parameters of the model (which may be treated as uncertain):

  V = IAM(Decisions, Climate Science, Etc.)
- Value of information is again the difference between best value possible without information and best value possible with information.

Climate Social Science Workshop, April 30, 2004 14

Slide 15

Here Are Some Results Obtained This Way

Benefits of Resolving Uncertainty
Now Rather than in 50 Years
(billions of 1990 dollars)
Nordhaus and Popp (1997)

Uncertain Parameter	Benefit of Uncertainty Resolution Now	Benefit of Uncertainty Resolution in 20 years
Cost of climate change (damages)	30.89	18.58
Cost of reducing emissions	16.48	10.24
Climate sensitivity (for 2xCO2)	6.91	4.27
Population growth decline	4.84	3.69
Decline of GHG/output ratio	2.4	2.08
GHG atmospheric retention rate	1.0	0.56
Productivity growth decline	0.09	0.09

Climate Social Science Workshop, April 30, 2004 15

Slide 16

Next Steps in Weather/Climate Valuation

- Develop comprehensive inventory of situations where information may produce benefits.
- Include benefit estimates (e.g. for ENSO forecasts) when these are available.
- Develop a research plan to fill in benefit estimates where these are lacking.
- Maintain the information over time as new results become available.

Slide 17

Develop Research Plan

- Think about how forecasts are used and what difference they may make to users.
- Consider likely scale of benefits of forecasts and use this to help set research priorities.
- Consider alternative value estimation methods and their likelihood of success to help set research priorities.
- Goal: work first on benefits that appear big and/or easy to estimate.

Slide 18

Roshydromet Recently Asked for Help with a Survey

- Roshydromet was planning a survey to identify users of its forecasts and estimate forecast values.
- Rather than simply asking "What are services worth to you?" we recommended a sequence of questions leading respondents to consider:
  (1) effects of different weather
  (2) how a forecast might improve decisions
  (3) what benefits arise from better decisions.

Slide 19

The Sequence of Questions Might Go Like This:

- What types of weather make a difference for your industry? For each type of weather ...
- How would you operate with a perfect weather forecast?
- How would you operate with no weather forecast?
- How much cost might be saved by having a perfect forecast?

Slide 20

Answers Can Be Used To Produce Value Estimates

- Cost savings from knowing weather for sure, multiplied by the probability of each kind of weather and summed over kinds of weather, is an estimate of the expected value of a perfect forecast.
- Other studies could be used to roughly estimate the fraction of this value that would be realized from a real world (I.e. imperfect) forecast.

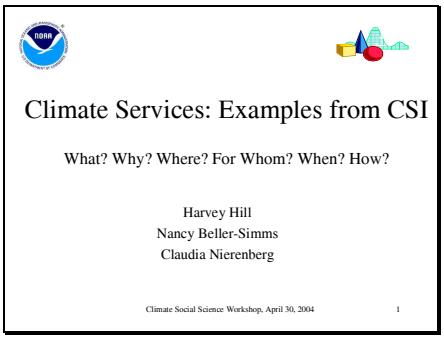
Slide 21

References

1. Solow, A.R. et. al., "The Value of Improved ENSO Prediction to United States Agriculture," Climatic Change, Vol. 39, 1998, pp. 47-60.
2. Nordhaus, William D. and David Popp, "What is the Value of Scientific Knowledge? An Application to Global Warming Using the PRICE Model," The Energy Journal, Vol. 18, No. 1, 1997, pp. 1-45.

Climate Services: Examples from CSI – Harvey Hill, Nancy Beller-Simms and Claudia Nierenberg

Slide 1



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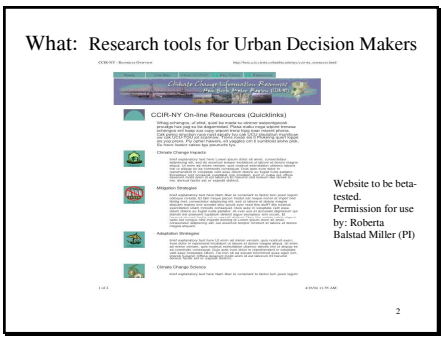


Slide 3

Why: Tools for Drought and Flood Planners

Mapping Vulnerability

Roberto Sanchez (PI)

Disasters
Data Bases
1972-2001
Events,
Damages
Consequences
Actions

Census Data
1990
2000

GIS
Watershed Analysis
Urban Growth 1972-2000
Land Use
Modifications to the landscape
Hazardous Areas
Urban Marginality
Vulnerability Analysis

Hazardous Areas
Land slides (Radius)
Flooding

Urban Growth
Aero photos
72, 89, 94, 2000
Satellite image 2001

Urban Data
Public services
Developments
Drainage

Landscape
Soils, geology, hydrology, vegetation, topography

Detailed case study
Colonia 3 de Octubre urbanization, social processes, assets

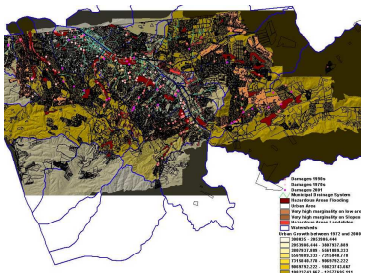
Interviews
Hazardous areas
Social profile
Risk perception
Assets

Interviews
Decision makers
Use climate forecast
Risk perception

Climatic Variability
Extreme precipitation
ENSO

3

Slide 4



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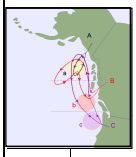
Slide 5

Climatic Variations and the International Management of the North American Pacific Salmon Fishery: A Game Theoretical Approach - K. Miller and R. McKelvey



Salmon spawned in one area, harvested in another. Aggressive harvesting led to breakdown of cooperation between US and Canada.

Mathematical game model developed to simulate negotiation patterns, changes in fish stock, and the effects of scientific information.

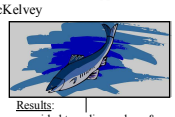
Sampling of Factors Included in Model

Fish characteristics (spawning stock, size of offspring, location of fishing grounds, etc.)

Environmental factors (including climatic regime shifts)

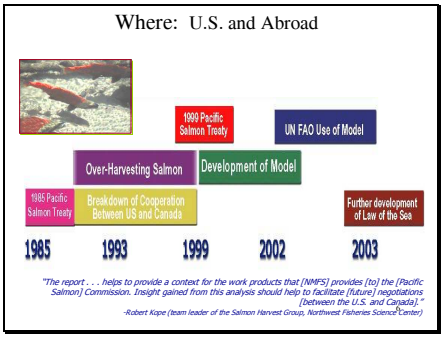
Cooperative and competitive payoffs to players

Quality and accessibility of information



Results:
provided to policy makers & stakeholders in region.
used by UN Food & Agric. Organization at international meeting on management of shared fish stocks.
results used as state-of-the-art advice for future talks on shared fishery regimes.
Material to be used in further development of Law of the Sea re: fisheries.

Slide 6



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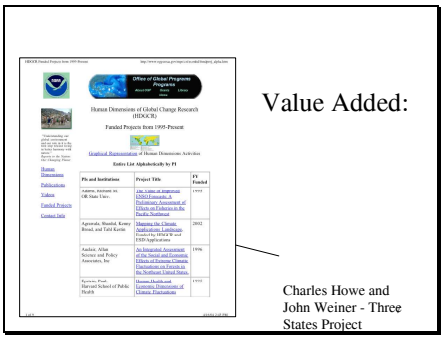


Value Added:

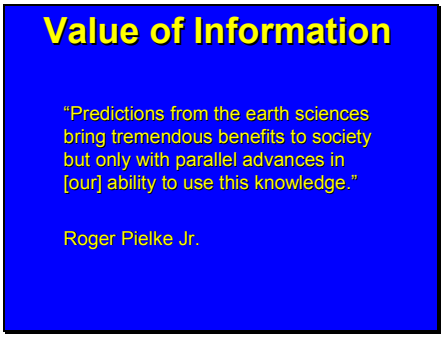
Charles Howe and John Weiner - Three States Project

Climate Information and Decision Support: User-Driven Research and Operational Services - David Letson

Not presented because of time constraints.

Slide 1

Slide 2



Slide 3

(1) Who We Are

Jim Jones, , Keith Ingram, Shrikant Jagtap, Clyde Fraisse and Peter Hildebrand, Univ. of Florida/IFAS

Kenny Broad, David Letson, Fernando Miralles-Wilhelm, Guillermo Podestá & Norman Breuer, Univ. of Miami/RSMAS

J.J. O'Brien & David Zierden, *COAPS*/Florida State University

Gerrit Hoogenboom & David Stooksbury, University of Georgia

Slide 4

Climate Variability:
ENSO in the SE USA

ENSO affects SE USA Climate

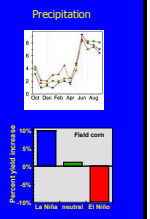
- Lower (higher) temps in El Niño (La Niña)
- Higher (lower) in El Niño (La Niña)
- Hurricanes
- Winter freezes (higher probabilities in Neutral winters)

ENSO affects Crops and Forests

- Winter vegetables
- Field crops
- Pasture
- Citrus
- Forest fires

ENSO affects the Environment

- Nitrate leaching



Slide 5

(2) What We Do

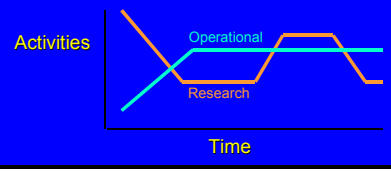
User-Driven Research & Operational Services.

A worthwhile balancing act.
- –Relevance
- –Access
- –Trust

Slide 6

Sustainable Implementation

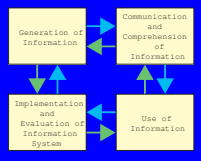
Academics must partner with operational entities.
- Initial, research-intensive stages.
- Quest for a sustainable balance.



Slide 7

A Climate Information System

A process including:
- Several components
- Not only climate forecasts
- Continuous evaluation and incorporation of feedback



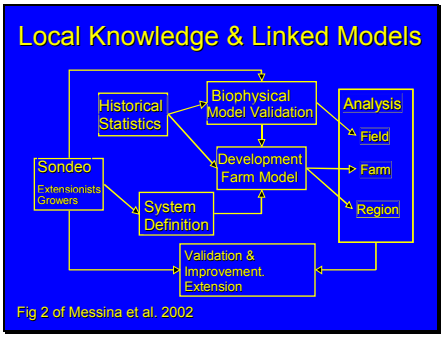
Adapted from: Sarewitz, Pielke and Byerly 2000. *Prediction*. Island Press. Page 376.

Slide 8

(3) A Participatory Systems Approach

- learn user needs for and perceptions of climate forecasts
- evaluate usefulness and limitations of climate forecasts
- translate climate forecasts into decision support for agriculture
- demonstrate successful forecast applications

Slide 9



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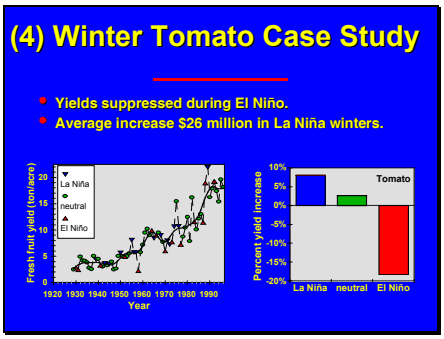

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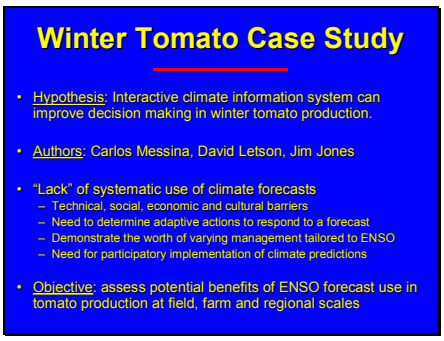


Slide 12

Adaptive Actions

Field Scale	Farm scale	Regional scale
•Selection of fields with different soils and topography •Maintain drainage channels •Selection of varieties •Transplanting date •Plant backup seedlings •Create wind breaks •Pesticide management •Select irrigation systems •Fertilizer management	•Crop mix* •Total planting area •Pattern of planting dates •Partially shift production among locations (e.g. between Florida and Puerto Rico)	•Control regional production & prices

Slide 13

Changeable Management Practices

Land preparation, varieties, labor, market, regulations, IPM, irrigation, harvest, insurance, field management, pesticide application, etc.

What we can model:
Planting date, variety, insurance, area planted.

Slide 14

Forecast Value at Field and Regional Scales

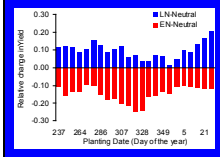


Fig 3 : Field

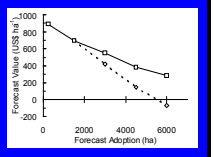


Fig 6: Region

Slide 15

Lessons

User-driven research & operational service

Partnering organizations offer access

Patience

Slide 16

For More Information

Please Visit Our Websites

Southeastern Climate Consortium:
www.flagsafe.ufl.edu/secc/

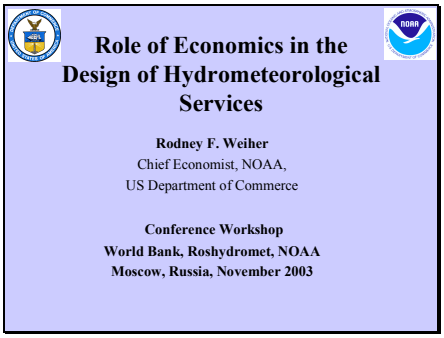
Florida Climate Center:
www.coaps.fsu.edu/climate_center

FAWN: fawn.ifas.ufl.edu

Part 3: Supplement - Nov. 2003 Russia Presentations on Value of Weather Forecasts and Inventory of Estimates of Value of Weather Information

Role of Economics in the Design of Hydrometeorological Services – Rodney F Weiher

Slide 1



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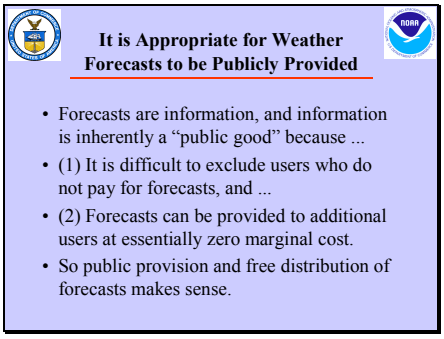

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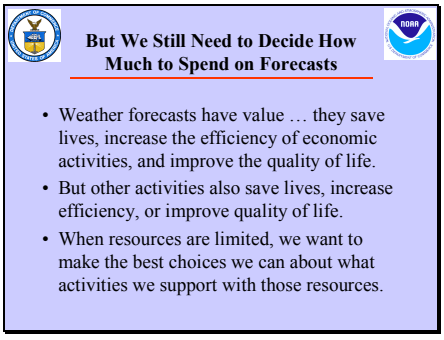

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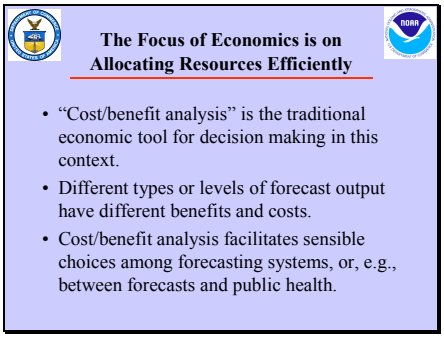

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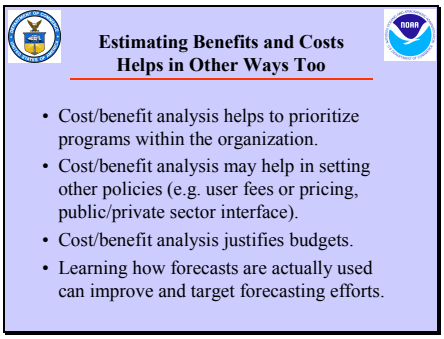
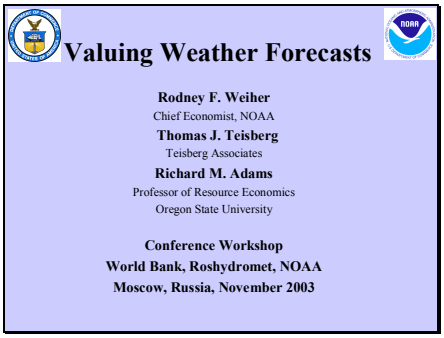


Valuing Weather Forecasts - Rodney F. Weiher, Thomas J. Teisberg and Richard M. Adams

Slide 1



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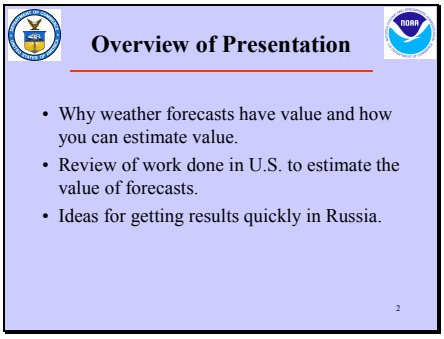

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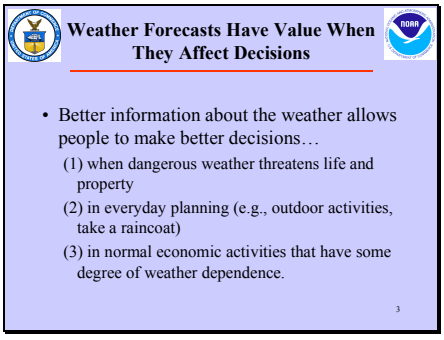

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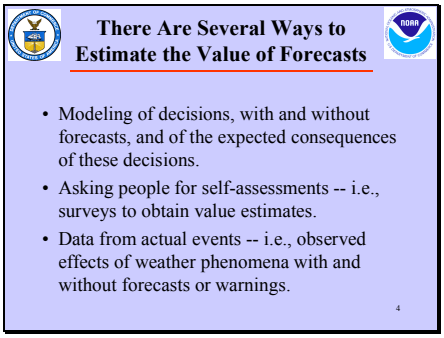

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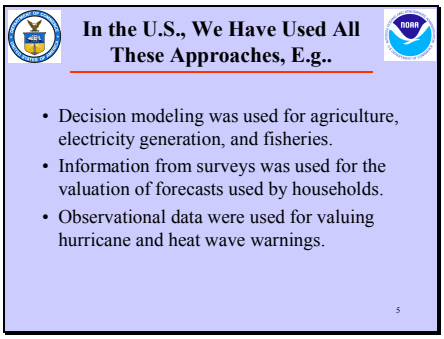

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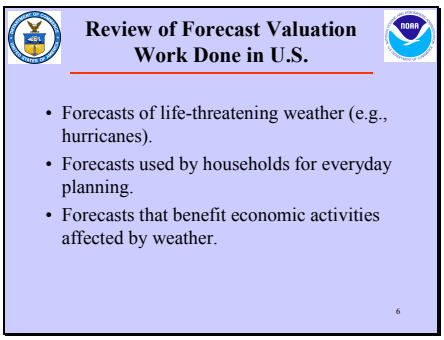

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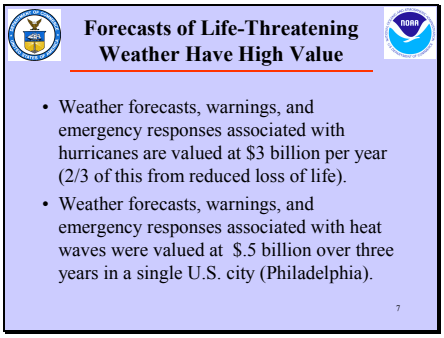

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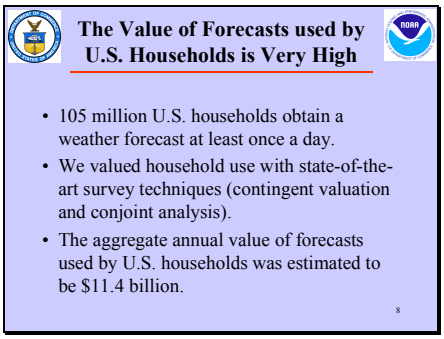

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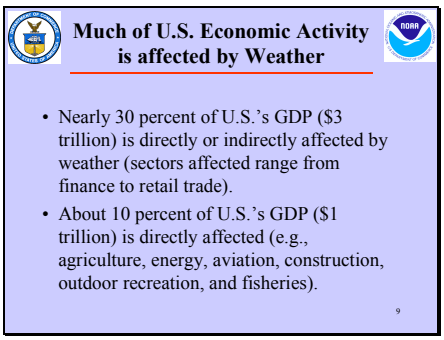

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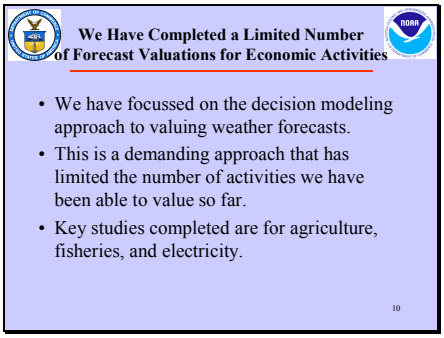

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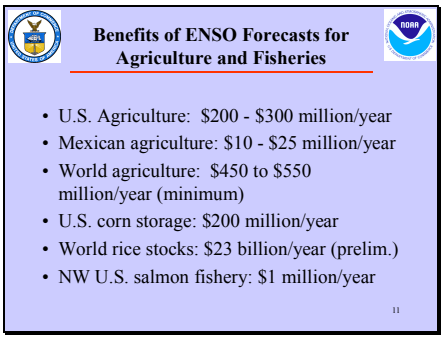

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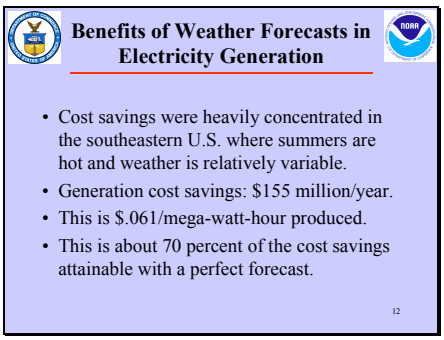

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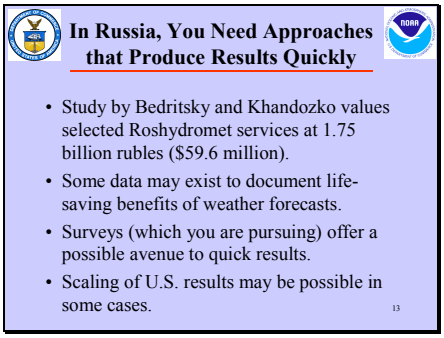

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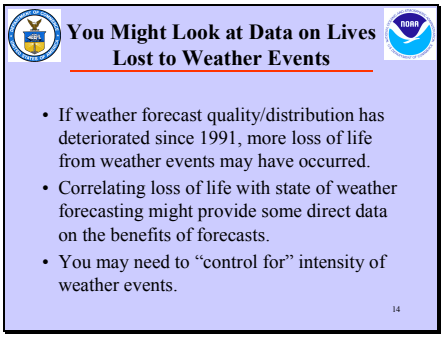

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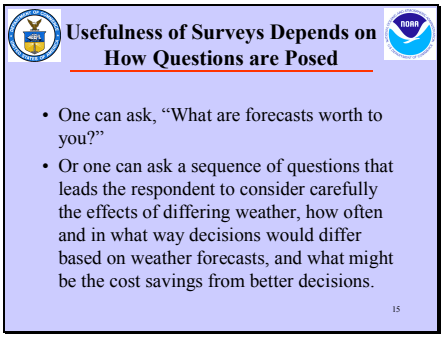

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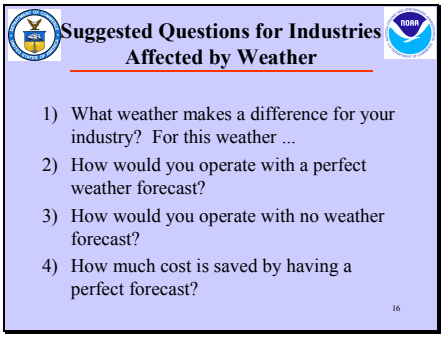

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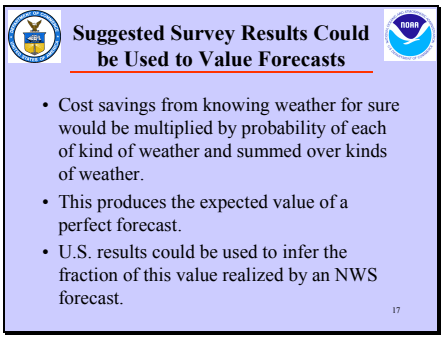

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Slide 19

Some Existing Results Expressed Relative to Sectors ...

- Value of weather forecasts for Australia and U.S. agriculture is about $1/acre (or 2 to 3 percent of U.S. on-farm income).
- Long-range weather forecasts add up to 5% to value of U.S. Pacific NW salmon fishery.
- U.S. electricity generation costs savings from forecasts are $.061/mega-watt-hour.
- U.S. and Australian households value forecasts at $16-20/household per year.

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Summary

- Weather forecasts do save lives...
- And forecasts have substantial economic value across sectors and countries.
- Existing studies and on-going surveys can provide quick value estimates for Russia.
- In the longer term, economic methods could guide development of cost-effective and sustainable hydrometeorological services.

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Slide 21

References

- Adams, Richard M., Laurie L. Houston, Bruce A. McCarl, Mario Tiscareno L., Jaime Matus G., Rodney F. Weiher. "The Benefits to Mexican agriculture of an El Nino Southern Oscillation (ENSO) Early Warning System." *Agricultural and Forest Meteorology* 115: 183-194. 2003.
- Adams, Richard M., Chi-Chung Chen, Bruce A. McCarl, and Rodney F. Weiher. "The Economic Consequences of ENSO Events for Agriculture." *Climate Research* 13: 165-172, 1999.
- Adams, Richard M. Chi-Chung Chen, Bruce A. McCarl, and Rodney Weiher. "The Economic Consequences of ENSO Events: the 1997-98 El Nino and the 1998-99 La Nina." Faculty Paper Series. Faculty Paper 99-2, December 1998. Department of Agricultural Economics, Texas A&M University, College Station TX.
- Anaman, K. A., Lellyett, S. C., Drake, L., Leigh, R. J., Henderson-Sellers, A., Noar, P. F., Sullivan, P. J., & Thampapillai, D. J. "Benefits of meteorological services: evidence from recent research in Australia." *Meteorological Applications*, 5: 103-115, 1998.
- Bedritsky, A.I. and L.A. Khandozko. "The Economic benefits of hydrometeorological services." *World Meteorological Organization Bulletin*, 50: 219-223, 2001.
- Chen, Chi-Chung, Bruce A. McCarl, and Richard M. Adams. "Economic Implications of Potential ENSO Frequency and Strength Shifts." *Climatic Change* 49: 147-159, 2001.
- Costello, Christopher J., Richard M. Adams, and Stephen Polasky. "The Value of El Nino Forecasts in the Management of Salmon: A Stochastic Dynamic Assessment." *American Journal of Agricultural Economics* 80 (November 1998): pp. 765-777, 1998.

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References

- Freebairn, J.W. and Zillman, J.W. "Economic benefits of meteorological services." *Meteorological Applications*, 9 (1): 33-44, 2002.
- Harrison, M.S. and N.E. Graham. "Forecast quality, forecast applications and forecast value: cases from southern African seasonal forecasts." *World Meteorological Organization Bulletin* 50: 228-231, 2001.
- Lazo, Jeffrey K. "Economic Value of Current and Improved Weather Forecasts in the US Household Sector." Report prepared for Rodney F. Weiher, Chief Economist, Program Planning and Integration, NOAA, by Stratus Consulting, Boulder CO, November 2002.
- Solow, Andrew R., Richard M Adams, Kelly J. Bryant, David M. Legler, James J. O'Brien, Bruce A. McCarl, William Nayda, and Rodney Weiher. "The Value of Improved ENSO Prediction to U.S. Agriculture." *Climatic Change* 39: 44-60, 1998.
- Teisberg, Thomas J., Kristie L. Ebi, Laurence S. Kalkstein, Lawrence Robinson, and Rodney F. Weiher. "Heat Watch/Warning Systems Save Lives: Estimated Costs and Benefits for Philadelphia 1995-1998." Forthcoming in *Bulletin of the American Meteorological Society*.
- Teisberg, Thomas J. and Rodney F. Weiher. "The Value of National Weather Service Forecasts in Scheduling Electricity Generation." Draft, forthcoming December 2003.
- Zillman, J. W. "The National Meteorological Service." *WMO Bulletin*, 48 (2), April, 129-159, 1999.
- Zillman, J. W. and Freebairn, J. W. "Economic framework for the provision of meteorological services." *WMO Bulletin*, 50 (3), May, 206-215, 2001.

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Inventory of Estimates of Value of Weather Information and References for Estimates

Estimates of Value of Weather Information

Table 1. Agriculture: value of long-term weather forecasts

Type of Information	Value of Weather Information	% of Sector	Source
Precipitation forecasts	Imperfect: $11/ha-yr perfect: $19/ha-yr derived from implementing wheat harvest strategies such as early harvesting, drying, and contract harvesting		Abawi et al. (1995)*
ENSO early warning system	Imperfect: $20-31 million/yr Perfect: $59-79 million/yr from 5 important agricultural states in Mexico	0.3-2% of crop production value in the 5 states	Adams et al. (2002)
ENSO predictions	Imperfect: $168 million/yr Perfect: $254 million/yr from Southeast U.S. agricultural region	1-2% of net income of U.S. farmers	Adams et al. (1995)*
Precipitation and temperature forecasts	Imperfect: $848-$2,276 Perfect: $1,314-$2,800 derived from wool producers in Victoria Australia		Bowman et al. (1995)*
Changes in ENSO frequency and strength	$482-$592 million per year From global agriculture's use of an ENSO monitoring and early warning system		Chen et al. (2002)
ENSO predictions	Imperfect: $507-$959/yr million Perfect: $1,768 million/yr from US agriculture		Chen et al. (2002)*
Southern African seasonal forecasts	Imperfect: $178 million Perfect:$0.72 billion		Harrison and Graham (2001)
Precipitation, temperature, and radiation forecasts	Imperfect $0-$102/ha-yr from Texas sorghum producers		Hill et al. (1999)*
Precipitation, temperature, and radiation forecasts	Imperfect: $0-11/ha-yr Perfect:$10-57/ha-yr from planning fertilizer applications on US and Canadian wheat fields		Hill et al. (2000)*
Precipitation and temperature forecasts	Imperfect: $-159-$5/section-yr Perfect:$-49-129/section-yr from livestock ranchers in Texas		Jochec et al. (2001)*
Maximum and minimum temperature, precipitation, and radiation forecasts	Imperfect $6-$17/ha-yr from corn, soybean, sunflower, and wheat producers in Argentina		Messina et al. (1999)*
Precipitation, temperature, and radiation forecasts	Perfect: $1.4-$3.2 billion over 10 years from making fertilizer application decisions in the Corn Belt region		Mjelde and Penson (2000)*
Precipitation forecasts	Imperfect: $1,170-14,520/farm Perfect: $19,900/farm from crop type, nitrogen application, Federal Farm Program participation, and		Mjelde et al. (1996)*

	crop insurance decisions		
Precipitation forecasts	Imperfect: $1.2-2.3/acre from fertilizer application level, planting date and seeding rate decisions		Mjelde et al. (1997)*
ENSO predictions	Imperfect: $297-$329 million/yr Perfect: $400 million/yr from US agriculture	1-2% of net income of U.S. farmers	Solow et al. (1998)*
*Values were obtained from Exhibit A.2. of Stratus Consulting report by Lazo et al. 2003. Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service and historical exchange rates from http://www.x-rates.com/.			

Table 2. Agriculture: value of short-term weather forecasts

Type of Weather Information	Value of Weather Information	% of Sector Value	Source
Frost forecast	Perfect forecast: $6,210/hectare/yr for apple orchards $3,781/hectare/yr for pear orchards $2,076/hectare/yr for peach orchards		Katz et al. (1982)*
Frost forecast	Imperfect forecast: $2,642/ha-yr for pear orchards Perfect forecast: $4,203/ha-yr for pear orchards		Baquet et al. (1976)*
Precipitation, temperature, and evaporation forecasts	Perfect forecast: $105/ha/yr for alfalfa		Wilks et al. (1993)*
Precipitation forecast	Imperfect forecast: -$116 to +$276/ha-yr Perfect forecast: $0-$276/ha-yr Winter wheat production in Canada		Fox et al. 1999a*
Precipitation forecast	Imperfect forecast: -$4.5 to +$27/ha-yr Perfect forecast: $3-$55/ha-yr Alfalfa dry hay production in Canada		Fox et al. 1999b*
Precipitation, temperature, and wind forecasts	Imperfect forecast: $379,248/yr for cotton producers in Australia		Anaman and Lellyett (1996)*
Precipitation and temperature forecasts	Imperfect forecast: $1040-$1156/ha-yr for lettuce irrigation timing in a humid US climate		Wilks and Wolfe (1998)*
Precipitation and frost timing	Imperfect: 20% increase in profit for wheat producers in Australia Perfect: 15% of value of perfect forecasts is achieved by present forecasts		Hammer et al. (1996)*
Temperature forecasts	Imperfect: $0.38-$1.09/dollar of insurance premium		Lou et al. (1994)*
Improved satellite imager and sounder which improve short-term (3-hr) temperature forecasts	$9 million/year derived from improvements in frost mitigation		NOAA (2002)
Improved satellite imager and sounder which improve evapotranspiration estimates	$33 million/year derived from improved irrigation efficiency		NOAA (2002)

*Values were obtained from Exhibit A.1. of Stratus Consulting report by Lazo et al. 2003.

Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service and historical exchange rates from http://www.x-rates.com/.

Table 3. Aviation: value of weather forecasts

Type of Weather Information	Value of Weather Information	% of Sector Value	Source
Improved weather forecasts in the form of terminal aerodrome forecasts	$12.3 million per year		Anaman et al. 1998
Terminal Convective Weather Forecast	$580 million/yr derived from delay reductions	6% of weather delay at the Terminal Convective Weather Forecast sites (0.61% of DDP from air transportation)	Sunderlin and Paull 2001*
Integrated Icing Diagnostic Algorithm	$33.7 million/yr from reduced accidents	Approximately 0.04% of GDP from air transportation	Paull 2001*
Improvement of Terminal Aerodrome Forecasts	$10 million per year for all Quantas international flights* imperfect:$6.8 million/year perfect: $8.4 million/year derived from the Quantas Airlines avoidance of carrying extra fuel		Leigh 1995* and http://www.esig.ucar.edu/HP_rick/esig.html Accessed March 1, 2004
Improvements in satellite imager and sounder	$58 million/year from reduced delays and accidents. ($40 million derived from reduced flight delays, and $18 million derived from avoiding volcanic ash plumes)	Approximately 0.06% of GDP from air transportation	NOAA 2002*
Integrated terminal weather system services	$176 million/yr from improved decision making resulting in reduced gridlock and reduced delays	Approximately 0.19% of GDP from air transportation	Allan et al. 2001*
Weather sensing and forecasting	$590 million/year from national delay reduction benefits (i.e. $16.7 million SEA, $25.7 million LAX, $119 million SFO)	Approximately 0.62% of GDP from air transportation	Evans et al. 1999*
Weather systems processor (WSP) modifications	$25 million/year from reduced flight delays as a result of national deployment of WSP	Approximately 0.022% of GDP from air transportation	Rhoda and Weber 1996*

*Values were obtained from Stratus Consulting report by Lazo et al. 2003, Exhibit A.2.

Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service and historical exchange rates from http://www.x-rates.com/. Percent of GDP is based on 1999 GDP figures from U.S. Census Bureau, Statistical Abstract of the United States: 2001, p. 418

Table 4. Energy: value of weather forecasts

Type of Weather Information	Value of Weather Information	% of Sector Value	Source
Improved long-range weather forecasts of ENSO and PDO	$161 million/year derived from more efficient reservoir operations and hydropower sales on spot markets	0.75% of GDP from electric, gas, and sanitary services	Hamlet et al. (2002)
Improved satellite imager and sounder which will improve max and min temperature predictions	$7.4 million/year derived from load forecasting efficiency for natural gas providers in the US	0.003% of GDP from electric, gas, and sanitary services	NOAA (2002)
Improved satellite imager and sounder which will improve max and min temperature predictions	$504 million/year Derived from load forecasting efficiency for electric utility providers in the US	0.23% of GDP from electric, gas, and sanitary services	NOAA (2002)
Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service. Percent of GDP is based on 1999 GDP figures from U.S. Census Bureau, Statistical Abstract of the United States: 2001, p. 418			

Table 5. Transportation: value of weather forecasts

Type of Weather Information	Value of Weather Information	% of Sector Value	Source
Commercial			
Improved satellite imager and sounder which improve short-term ice formation and fog conditions	$29 million/year derived from rerouting efficiencies in the trucking industry	0.02 % of GDP from trucking and warehousing	NOAA (2002)
Improved satellite imager and sounder which will improve marine forecasts of winds and waves	$95 million/year to commercial shipping from transit time savings and cargo loss reductions	0.66% of GDP from water transportation	NOAA (2003) Draft
General transportation			
Daily precipitation predictions from radar imagery	imperfect: $35,000 per year, derived from deciding whether to apply de-icing materials for a single Regional Council in Scotland		Smith and Vick 1994
Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service and historical exchange rates from http://www.x-rates.com/. Percent of GDP is based on 1999 GDP figures from U.S. Census Bureau, Statistical Abstract of the United States: 2001, p. 418			

Table 6. Commercial Fishery: value of weather forecasts

Type of Weather Information	Value of Weather Information	% of Sector Value	Source
El Nino forecasts	$0.16-1.16 million/yr from increases in producer and consumer surpluses	4% of Pacific annual Northwest Coho landings	Costello et al. (1998)
Improved satellite imager and sounder which will improve accuracy of biomass survey results	$3.08 million from commercial fishing	0.10% of US annual fish landings	NOAA (2003draft)
Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service and historical exchange rates from http://www.x-rates.com/. Percent of sector value estimates were based on annual landing values reported by the National Marine Fisheries Service. http://www.st.nmfs.gov, accessed April 1, 2004			

Table 7. Household: value of weather forecasts

Type of Weather Information	Value of Weather Information	% of Sector Value	Source
Australian Public Weather Service	$22/year/taxpayer in Australia		Anaman Lellyett (1996)
NOAA weather service	$16.80 per household ($1.8 billion nationally) for improving forecasts in the US to maximum possible $12 billion per year nationally for existing weather services		Lazo(2002)
Ontario Canada public weather forecasts	$1 billion per year in Ontario Canada		Brown (2002)
Improved local weather forecasts in Denver	Perfect: $80 million for Denver households, $160 per person		NOAA (1979)*
*Values were obtained from Stratus Consulting report by Lazo et al. 2003, Exhibit A.2. Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service and historical exchange rates from http://www.x-rates.com/			

Table 8. Recreation and Other: value of weather forecasts

Type of Weather Information	Value of Weather Information	% of Sector Value	Source
Recreation (boating, golfing and fishing)			
Improved satellite imager and sounder which will improve hurricane intensity forecasts	$31 million/year from damage avoidance in recreational ocean boating	0.04% of GDP from amusement and recreation services	NOAA (2002)
Improved satellite imager and sounder which will improve golf safety, irrigation efficiency, grounds maintenance and tournament and personal golf planning	$196 million/year from avoidable losses in recreational golfing	0.25% of GDP from amusement and recreation services	NOAA (2003)
Improved satellite imager and sounder which will improve accuracy of biomass survey results	$0.41 million/year from recreational fishing	0.0001% of GDP from amusement and recreation services	NOAA (2003)
Other (landscaping industry)			
Improved satellite imager and sounder which will improve irrigation and grounds maintenance efficiencies	$298 million per year from avoidable losses to residential landscaping industry	(NA)	NOAA (2003)
Note: For ease of comparison, all values were converted to 2004 US dollars using the CPI from the Economic Research Service.			

Improved satellite imager and sounder	$20 Lightning safety		NOAA (2003 draft)
Improved satellite imager and sounder which will improve hurricane intensity forecasts	$191 million/year (2003$) residential landscaping		NOAA (2003 draft)

OTHER

Mining industry in Australia would be willing to pay $5346 annually to have access to public weather and climate services (Anaman et al. 1997)

References for Estimates of Value of Weather Information

Abawi, G.Y., R.J. Smith, and D.K. Brady. “Assessment of the value of long range weather forecasts in wheat harvest management.” Journal of Agricultural Engineering Resources 62:39-48, 1995

Adams, Richard M., Laurie L. Houston, Bruce A. McCarl, Mario Tiscareno L., Jaime Matus G., Rodney F. Weiher. “The Benefits to Mexican agriculture of an El Nino Southern Oscillation (ENSO) Early Warning System.” Agricultural and Forest Meteorology 115: 183-194. 2003.

Adams, Richard M., Chi-Chung Chen, Bruce A. McCarl, and Rodney F. Weiher. “The Economic Consequences of ENSO Events for Agriculture.” Climate Research 13: 165-172, 1999.

Adams, Richard M. Chi-Chung Chen, Bruce A. McCarl, and Rodney Weiher. “The Economic Consequences of ENSO Events: the 1997-98 El Nino and the 1998-99 La Nina.” Faculty Paper Series. Faculty Paper 99-2, December 1998. Department of Agricultural Economics, Texas A&M University, College Station TX.

Adams, R.M., K.J. Bryant, B.A. McCarl, D.M. Legler, J.J. O’Brien, A.R. Solow, and R. Weiher. “Value of improved long-range weather information.” Contemporary Economic Policy, Western Economic Association International 13:10-19, 1995.

Alan, S.S., S.G. Gaddy, and J.E. Evans. “Delay Causality and Reduction at the New York City Airports Using Terminal Weather Information Systems.” Lexington, MA:MIT Lincoln Laboratory. 2001

Anaman, K. A., Lellyett, S. C., Drake, L., Leigh, R. J., Henderson-Sellers, A., Noar, P. F., Sullivan, P. J., & Thampapillai, D. J. “Benefits of meteorological services: evidence from recent research in Australia.” Meteorological Applications, 5: 103-115, 1998.

Anaman, K.A. and S.C. Lellyett. “Contingent valuation study of the public weather services in the Syndey metropolitan area.” Australian Economic Papers, 15(3), 64-77, 1996.

Anaman, K.A. and S.C. Lellyett. “Assessment of the benefits of an enhanced weather information service for the cotton industry in Australia. Meteorological Applications, 3, 127-135. 1996

Baquet, A.E., A.N. Halter, and F.S. Conklin. “The value of frost forecasting: A Bayesian appraisal.” American Journal of Agricultural Economics 58:511-520, 1976.

Bedritsky, A.I. and L.A. Khandozko. “The Economic benefits of hydrometeorological services.” World Meteorological Organization Bulletin, 50: 219-223, 2001.

Bowman, P.J., G.M. McKeon, and D.H. White. “An evaluation of the impact of long-range climate forecasting on the physical and financial performance of wool-producing enterprises in Victoria.” Australian Journal of Agricultural Research 46:687-702, 1995.

Brown, J. “The value of weather forecast services.” Department of Agricultural Economics and Business, University of Guelph, April 2002.

Chapman, R.E. “Benefit-Cost analysis for the modernization and associated restructuring of the National Weather Service.” NISTIR 4867. Report to the U.S. Department of Commerce, National Institute of Standards and Technology. Washington, D.C. 1992.

Chen, Chi-Chung, Bruce A. McCarl, and Richard M. Adams. “Economic Implications of Potential ENSO Frequency and Strength Shifts.” Climatic Change 49: 147-159, 2001.

Chen, C.-C., B. McCarl, and H.Hill. “Agricultural value of ENSO information under alternative phase definition.” Climatic Change 54:305-325, 2002.

Costello, C.J., R.M. Adams, S. Polasky. “The value of El Nino forecasts in the management of salmon: a stochastic dynamic Assessment.” American Journal of Agricultural Economics 80:765-777, 1998.

Economic Research Service. Contact: Mathew Shane (202-694-5282, mshane@ers.usda.gov)

Evans, J.E., T.J. Dacey, D.A. Rhoda, R.E. Cole, F.W. Wilson, E.R. Williams. “Weather Sensing and Data Fusion to Improve Safety and Reduce Delays at Major West Coast Airports.” Lexington, MA:MIT Lincoln Laboratory. 1999.

Easterling, W.E., and Mjelde, J.W. “The importance of seasonal climate prediction lead time in agricultural decision making.” Agricultural and Forest Meteorology, 40:37-50, 1987.

Fox, G., J. Turner, and T. Gillespie. “The value of precipitation forecast information in winter wheat production.” Agricultural and Forest Meteorology 95:99-111, 1999a.

Fox, G., J. Turner, and T. Gillespie. “Estimating the value of precipitation forecast information in alfalfa dry hay production in Ontario.” Journal of Production Agriculture 12:551-558, 1999b.

Freebairn, J.W. and Zillman, J.W. “Economic benefits of meteorological services.” Meteorological Applications, 9(1): 33-44, 2002.

Hamlet, A.F., Huppert, D., and Lettenmaier, D.P. “Economic value of long-lead streamflow forecasts for Columbia River hydropower.” Journal of Water Resources Planning and Management, 128, 91-101, 2002.

Hammer, G.L., D. P. Holzworth, and R. Stone. “The value of skill in seasonal climate forecasting to wheat crop management in a region with hich climatic variability.” Australian Journal of Agricultural Research 47:717-737, 1996.

Harrison, M.S. and N.E. Graham. “Forecast quality, forecast applications and forecast value: cases from southern African seasonal forecasts.” World Meteorological Organization Bulletin 50: 228-231, 2001.

Hill, H.S.J., J.W. Mjelde, W. Rosenthal, and P.J. Lamb. “The potential impacts of the use of Southern Oscillation information on the Texas aggregate sorghum production.” Journal of Climate 12:519-530, 1999.

Hill, H.S.J., J.Park, J.W. Mjelde, W. Rosenthal, H.A. Love, and S.W. Fuller. “Comparing the value of Southern Oscillation index-based climate forecast methods for Canadian and US Wheat producers.” Agricultural Forest Meteorology 100:261-272, 2000.

Jochec, K.G., J.W. Mjelde, A.C. Lee, and J.R. Conner. “Use of seasonal climate forecasts in rangeland-based livestock operations in West Texas.” Journal of Applied Meteorology 40:1629-1639, 2001.

Katz, R.W. and A.H. Murphy, Economic Value of Weather and Climate Forecasts. Cambridge University Press, 222 pp, 1997.

Katz, R.W., A.H. Murphy, and R.L. Winkler. “Assessing the value of frost forecasts to orchardists: A dynamic-analytic problem.” Journal of Applied Meteorology 21:518-531, 1982.

Lazo, J.K. “Economic value of current and improved weather forecasts in the US household sector, Report prepared for the National Oceanic and Atmospheric Administration. Stratus Consulting Inc., Boulder, CO. 2002.

Lazo, J.K., M.L. Hagenstad, K.P. Cooney, J.L. Henderson, and J.S. Rice. “Benefit analysis for National Oceanic and Atmospheric Administration high-performance computing system for research applications.” Prepared for: Joan M. Brundage, Chief Information Officer, National Oceanic and Atmospheric Administration/Office of Oceanic and Atmospheric Research, Aeronomy Laboratory,

Leigh, R.J. “Economic Benefits of Terminal Aerodrome Forecasts (TAFs) for Sydney Airport, Australia.” Meteorological Applications 2:239-247. 1995.

Lou, H., J.R. Skees, and M.A. Marchant. “Weather information and the potential for inter-temporal adverse selection in crop insurance.” Review of Agricultural Economics 16:441-451, 1994.

Messina, C.D., J.W. Hansen, and A.J. Hall. “Land allocation conditioned on ENSO phases in the Pampas of Argentina.” Agricultural Systems 60:197-212, 1999.

Meteorological Service of Canada Annual Report 2001-2002. http://www.msc-smc.ec.gc.ca/media/annual_report/2001-02/index_e.html Accessed February 18, 2004.

McNew, K. “The value of El Nino forecasts in agricultural commodity markets: the case of U.S. corn storage.” Email:kmcnew@arec.umd.edu, University of Maryland. 1999.

Mjelde, J.W. and J.B. Penson. “Dynamic aspects of the impact of the use of perfect climate forecasts in the Corn elt region.” Journal of Applied Meteorology 39:67-79, 2000.

Mjelde, J.W., T.N. Thompson, and C.J. Nixon. “Government institutional effects on the value of seasonal climate forecasts.” American Journal of Agricultural Economics 78:175-188, 1996.

Mjelde, J.W. Thompson, F.M. Hons, J.T. Cothren and C.G. Coffman. “Using Southern Oscillation information for determining corn and sorghum profit-maximizing input levels in East-Central Texas.” Journal of Production Agriculture 10:168-175, 1997.

Nicholls, J.M. “Economic and social benefits of climatological information and services: a review of existing assessments.” World Meteorological Organization, Geneva, Switzerland. WMO/TD-No. 780. 38 pp. 1996.

NOAA FY 04 Budget Summary. http://www.ofa.noaa.gov/~nbo/F%20-%20Table%2009%20-%20FY04%20Auth%20Table%20-%20Errata%20-%20Page%2099-100.pdf Accessed February 18, 2004.

NOAA, Geostationary operational environmental satellite system (GEOS) GOES-R sounder and imager cost/benefit analysis (CBA) – Phase III. Prepared for the Department of Commerce by National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data, and Information Service (NESDIS), Office of Systems Development, 2003.

NOAA, Geostationary operational environmental satellite system (GEOS) GOES-R sounder and imager cost/benefit analysis (CBA). Prepared for the Department of Commerce by National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data, and Information Service (NESDIS), Office of Systems Development, November 15, 2002.

NOAA, Prototype Regional Observing and Forecasting Service. Report of a study to estimate economic and vonvenience benefits of improved local weather forecasts. NOAA Technical Memorandum ERL PROFS-1. NOAA Environmental Research Laboratory, Boulder, CO. 1979.

Paull, G. “Integrated Icing Diagnostic Algorithm (IIDA) safety benefits analysis accident case studies.” Prepared for the FAA by MCR Federal, Inc. Bedford. MA. 2001

Rhoda, D.A. and Me. Weber. “Assessment of Delya Aversion Benefits of the Airport Surveillance Radar (ASR) Weather Systems Processor (WSP) – Project Report.” Lexington, MA:MIT Lincoln Laboratory. 1996.

Smith, K. and Vick, S.D. “Valuing weather radar benefits for winter road maintenance: a practical case example.” Meteorological Applications, 1, 173-177, 1994.

Solow, Andrew R., Richard M Adams, Kelly J. Bryant, David M. Legler, James J. O’Brien, Bruce A. McCarl, William Nayda, and Rodney Weiher. “The Value of Improved ENSO Prediction to U.S. Agriculture.” Climatic Change 39: 47-60, 1998.

Sunderlin, J. and G. Paull. “FAA Terminal convective Weather Forecast Benefits analysis.” Prepared for the FAA by MCR Federal, Inc. Bedford, MA. 2001.

Wilks, D.S., R.E. Pitt and G.W. Fick. “Modeling optimal alfalfa harvest scheduling using short-range weather forecasts.” Agricultural Systems 42:277-305, 1993.

Fox, G., J. Turner, and T. Gillespie. “The value of precipitation forecast information in winter wheat production.” Agrucultural and Forest Meteorology 95:99-111, 1999a.

Fox, G., J. Turner, and T. Gillespie. “Estimating the Value of precipitation forecast information in alfalfa dry hay production in Ontario.” Journal of Production Agriculture 12, 551-558, 1999b.

Zillman, J.W. “The national meteorological service.” WMO Bulletin, 48 (2), April, 129-159, 1999.

Zillman, J.W. “The state of national meteorological services around the world.” World Meteorological Organization Bulletin 52(4) October, 360-365, 2003.

Zillman, J.W. and Freebairn, J W. “Economic framework for the provision of meteorological services.” *WMO Bulletin,* 50 (3), May, 206-215, 2001.

Zillman, J.W. “The state of national meteorological services around the world.” World Meteorological Organization Bulletin 52(4) 360-365, 2003.